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BOOKLET

HOW TO BUILD A HOUSE

FROM SCRATCH WITH NATURAL MATERIALS WITH AN INTERNATIONAL GROUP OF FOLKS

ERASMUS+ TRAINING COURSE

Re-Joyce in resilience: natural building and community-led design



Joyce 'n' fun
MAKING THE WORLD A BETTER PLACE, ONE CHILD AT A TIME

ΙΔΡΥΜΑ ΝΕΟΛΑΙΑΣ & ΔΙΑ ΒΙΟΥ ΜΑΘΗΣΗΣ

PERMACULTURE ASSOCIATION OF BULGARIA

18

KORA

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building with earth

RAKENTO

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INTRODUCTION

Context and goals of the project

The Training Course took place **from October 4th to October 20th in Joyce Kingdom in Skiathos island (Greece)** and involved 24 youth workers from all over Europe. The Training Course focused on learning how to build a house from scratch using ecological construction methods and materials.

Participants worked with local and natural materials such as wood, stone, clay, straw. The entire process was based on teamwork, participatory building and hands-on experience.

<u>The main goals were:</u>

- Raise awareness and understanding of natural building techniques and how to apply them in practice.
- Equip participants with the knowledge and experience to become autonomous in building their own eco-friendly house or project.
- Explore the meaning of sustainability within the context of construction and architecture.
- Learning to live in community and contribute effectively to the daily activities and needs.
- Become more resilient and better prepared to live sustainably and face potential crises related to weather or climate conditions.
- Foster meaningful dialogue across cultures, faiths, and backgrounds through shared experiences.
- Create this booklet to support others in applying these ecological building practices.





HOW TO USE THIS BOOKLET?

Even though this booklet is as thorough as possible, for people with no, or few experience in building, it´s highly recommended to contact local architects or builders to help you in the process.

This building has been co-created and led by Lauranne from Degré 47 (**https://www.degre47.com/**) and Rui Cardoso from Colectivo Opcíon 18 (https://www.instagram.com/colectivo.op18/).

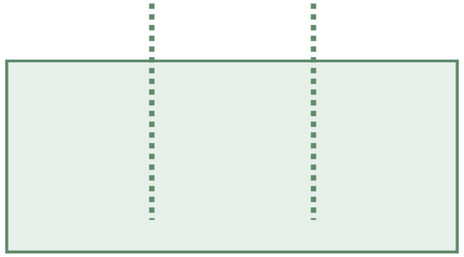
WHY DID WE CHOOSE THIS BUILDING?

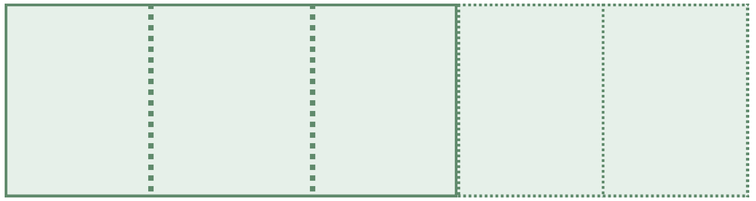
At Joyce Kingdom, there was a clear need to **expand the accommodation** provided for volunteers.

Based on the available layout, it was possible to either build three separate rooms or one unified space.The final decision was to construct **a single building that could be divided into three rooms** by adding internal partitions, curtains, or other light separations.

The selected design follows a modular structure, making it easily replicable in the future and allowing for flexible expansion whenever needed.







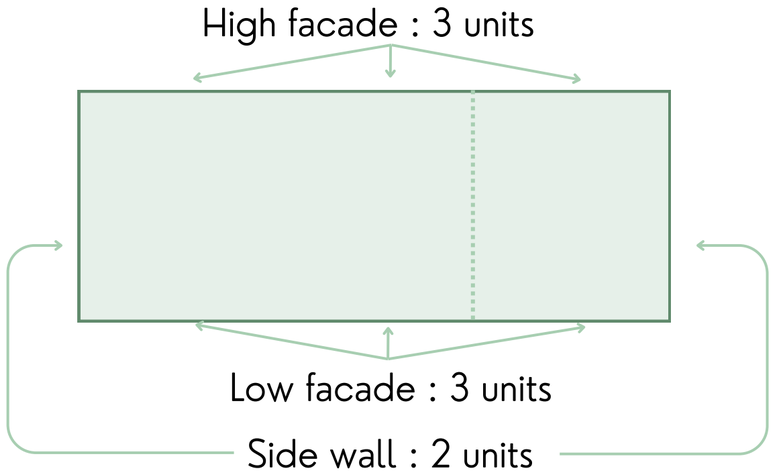
WHY DID WE CHOOSE THIS BUILDING?

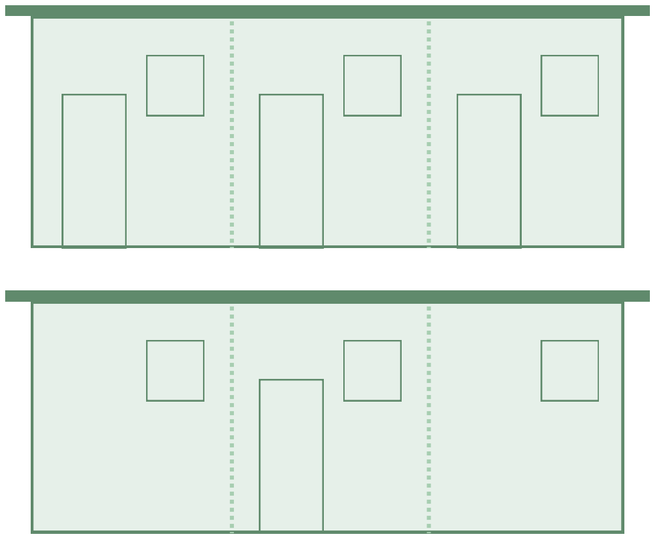
Each long facade of the building is composed of three main elements, **forming modular wall sections** built according to the same constructive principle.

- On the front facade (“low facade”), each wall includes a window and a door
- On the back facade (“high facade”), each wall includes a window to allow natural cross-ventilation between the front and rear of the building.

This layout ensures **good indoor air quality and offers flexibility in the spatial organization**: some partitions can be closed off to create private rooms, each with its own entrance door.

Another configuration is also possible **: a shared central space with a single main entrance** located in the middle of the de.
In this case, the existing windows provide natural light for each room while reducing the number of exterior openings that require maintenance and security.





SAFETY MEASURES



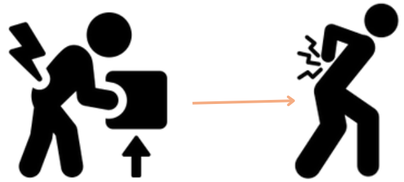
INDIVIDUAL SAFETY

- Wear closed, non-slip shoes (safety boots if possible).
- Always use gloves and safety glasses when needed.
- Protect your head (helmet or sturdy hat).
- Avoid loose clothing or jewelry.
- Stay hydrated and use sun protection
- Never run or push in the work area.
- Ask for help if unsure how to do something.
- Do not work at height alone or without supervision.
- Take care of your body when lifting load.

COLLECTIVE SAFETY

- Keep the site organized and clean.
- Mark dangerous areas and keep paths clear.
- Have a first aid point visible and accessible.
- Start each day with a short safety briefing.
- Assign a daily safety coordinator.
- Unplug power tools when not in use
- Store sharp tools safely after use
- Work in pairs or small groups, no one works alone.
- Respect everyone’s rhythm and ability.

DON’T



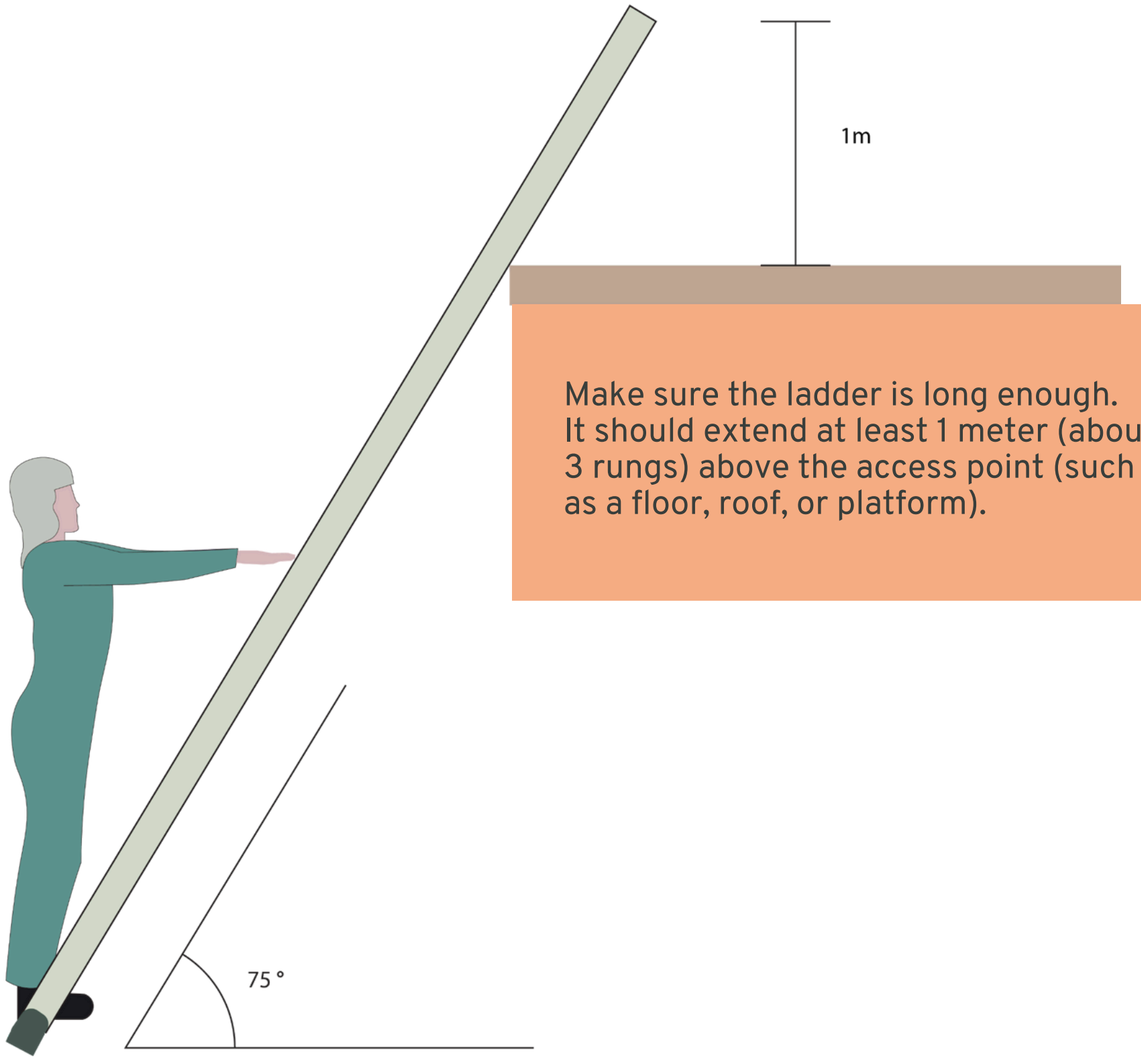
DO



LADDER SAFETY GUIDELINES

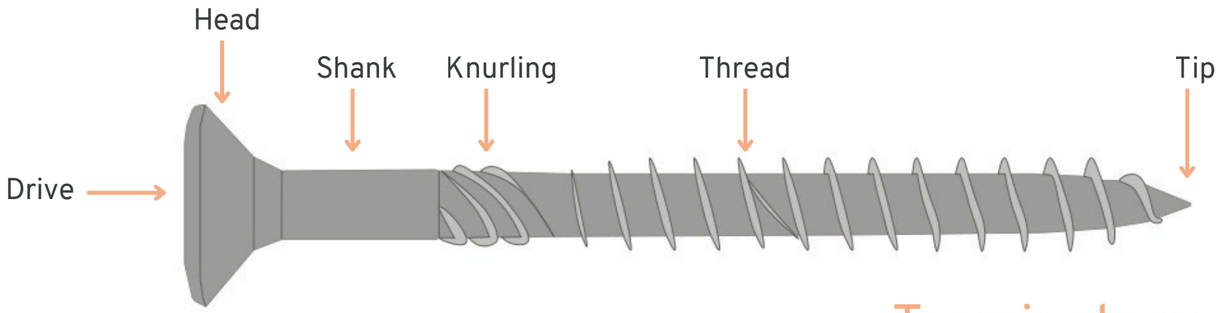
For good stability, the **angle** between the ladder and the ground should **be between 65° and 70°.**

To ensure this inclination, *here's a simple tip*: stand facing the ladder with your arms straight and your hands at shoulder height : the ladder's feet should touch your toes, and the top of the ladder should rest against the wall.



Make sure the ladder is long enough. It should extend at least 1 meter (about 3 rungs) above the access point (such as a floor, roof, or platform).

INFORMATIONS ABOUT SCREWS :

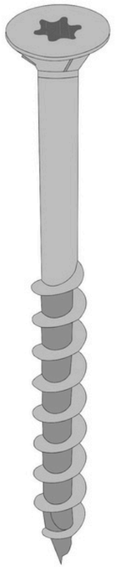


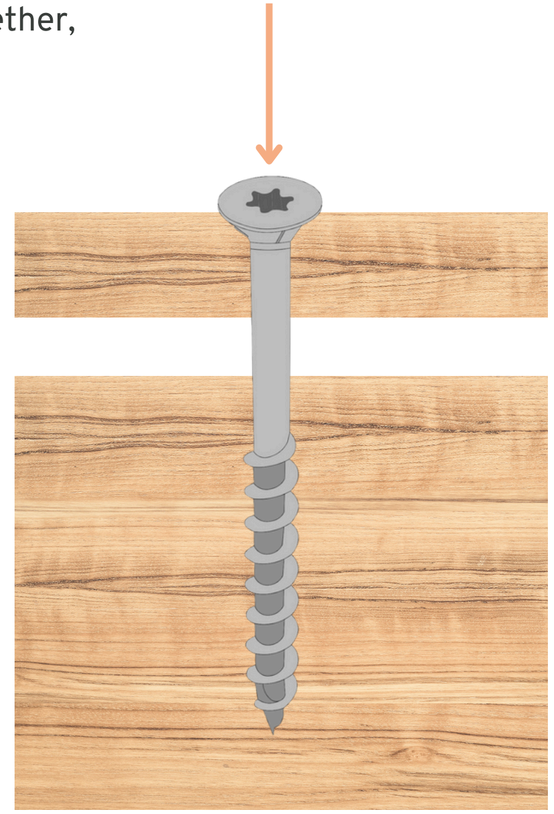
Terminology



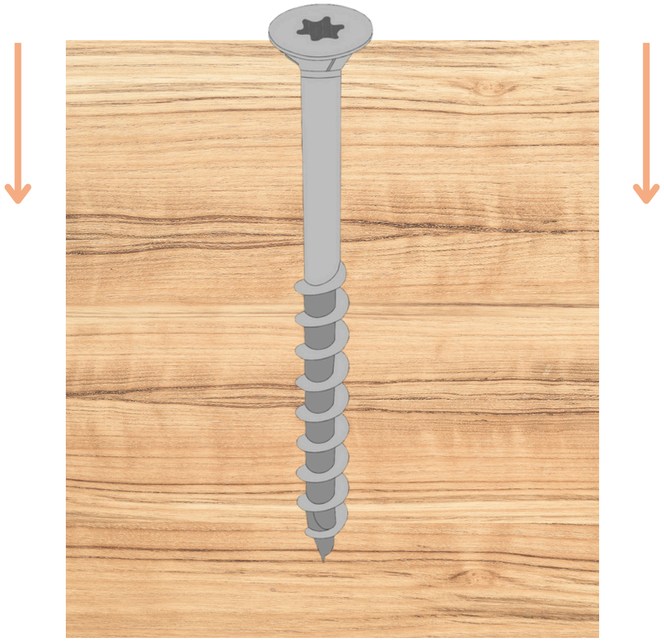
INFORMATIONS ABOUT SCREWS :

To assemble the wooden parts together, we use partially threaded screws.



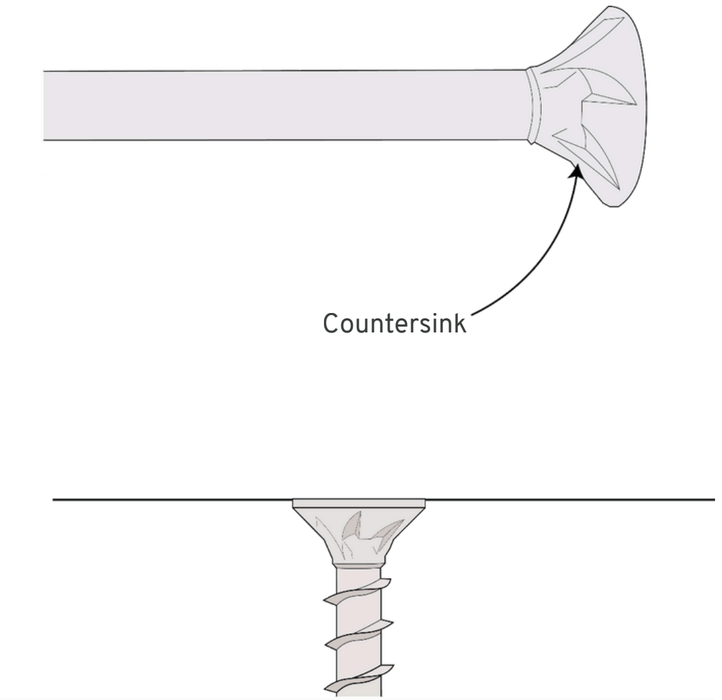


Wood piece A slides freely along the smooth part of the screw, while wood piece B is pulled tightly against it by the screw head as the threaded part grips into the wood.



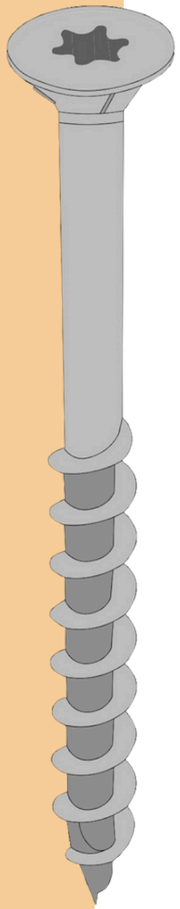


INFORMATIONS ABOUT SCREWS :



Countersink head: its conical shape allows it to slightly cut into the wood so that the screw head sits perfectly flush with the surface, without sticking out.

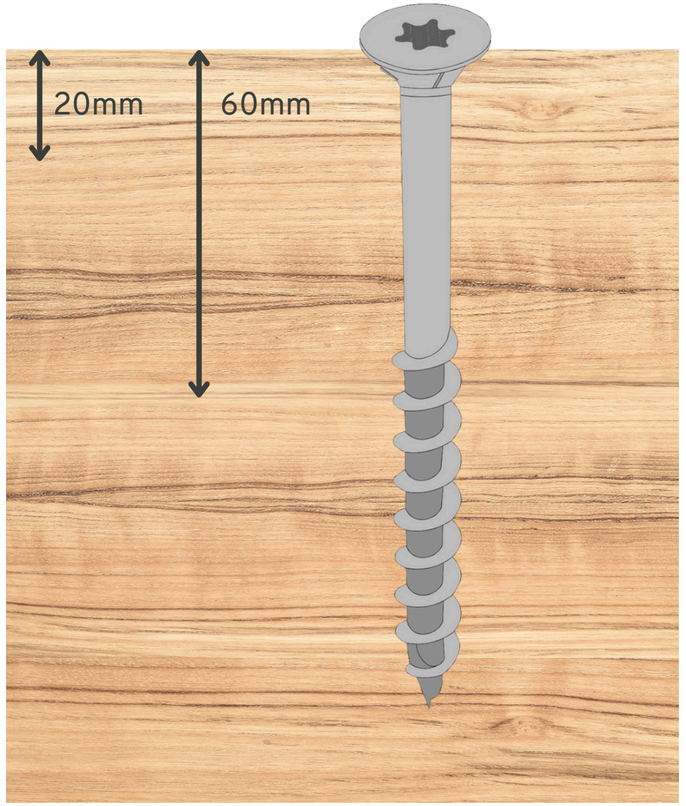
SCREWS



Head diameter
There are several possible types of screw heads.

Length
The length is an important factor, knowing it helps ensure strong and durable fixings.
If the screw is too short, the connection will be weaker; if it's too long and goes through the material, it loses effectiveness

The ideal screw length is generally considered to be **three times** the thickness of the piece of wood being fastened.



FLOATING TO DO LIST (TEAM 0)

The Floating To Do List is a **flexible list of tasks** that anyone in the group can pick up at any time. It is designed for participants who may not be directly involved in a specific activity at the moment, or prefer to contribute in another way.

The list includes a variety of small but meaningful tasks that support the overall progress of the project.

The tasks :

- Bring some water
- Clean the space (trash, rests of wood, organize tools)
- Check if some batteries have to charge
- Ask if someone needs help
- Do clay tests (go on page 68)
- Bring more material to the area (wood, stone, clay, sand)
- Put some separation sticks in between the stored wood (to avoid moisture)
- Relax and extend your body



BASICS ABOUT FOUNDATIONS

Foundations in Natural and Ecological Building

Foundations are the base of any construction. They **distribute the weight of the structure** through the ground and ensure the building remains stable over time.The choice of foundation depends on the type of soil, the weight of the building, and the materials available on site. Each type has a different purpose and leads to different results in terms of stability, drainage, and durability.

1. Shallow Foundations

Used when the soil is firm, dry, and well-drained. These are the simplest and most ecological types.

Examples:

- **Dry stone foundation** – stones laid directly on compacted soil.
- **Rubble trench foundation** (gravel and lime) – offers good drainage and stability.
- **Stone blocks** or stabilized earth bricks placed under the main walls.

2. Deep Foundations

Used when the upper layer of soil is soft, wet, or unstable.

Examples:

- Natural wooden posts driven into the ground.
- Stone or lime-and-gravel pillars reaching deeper, firmer soil.
- Ceramic, metal, or bamboo tubes filled with lime and gravel.

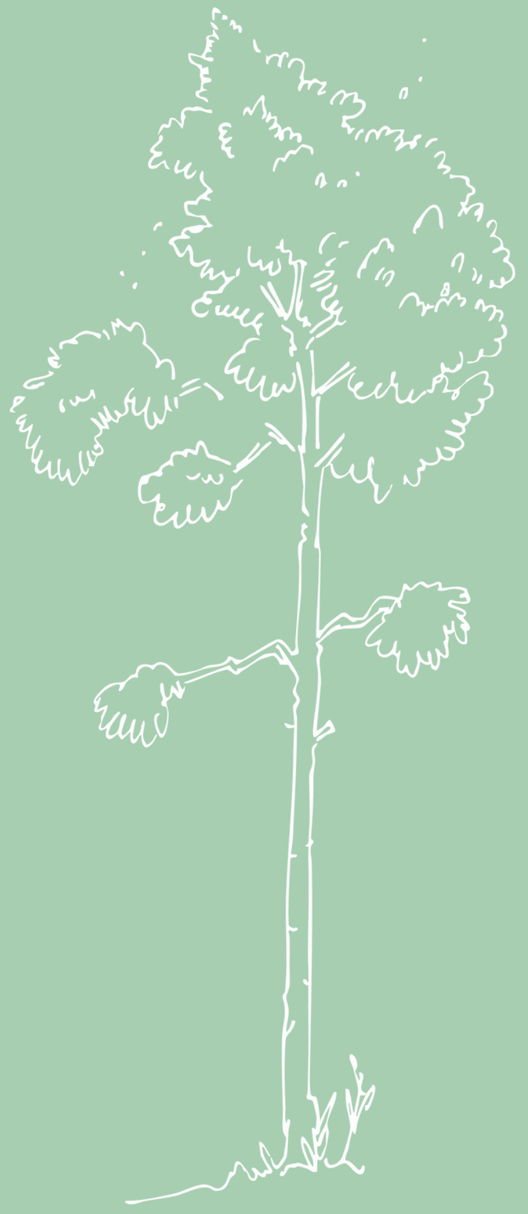
3. Draining Foundations

Essential in areas with groundwater or risk of flooding.

Examples:

- Drainage trenches with gravel and perforated pipes.
- Layers of sand and stone beneath the foundation to help water flow away.
- Raised or ventilated bases that allow air to circulate under the building.

T1.
FOUNDATION TEAM



FOUNDATION TEAM



MATERIAL : we will need: meter, level, hammer, metal bars, water level, pencils, rocks

1, Choose **the location** of your building : Select a stable, well-drained area suitable for construction.

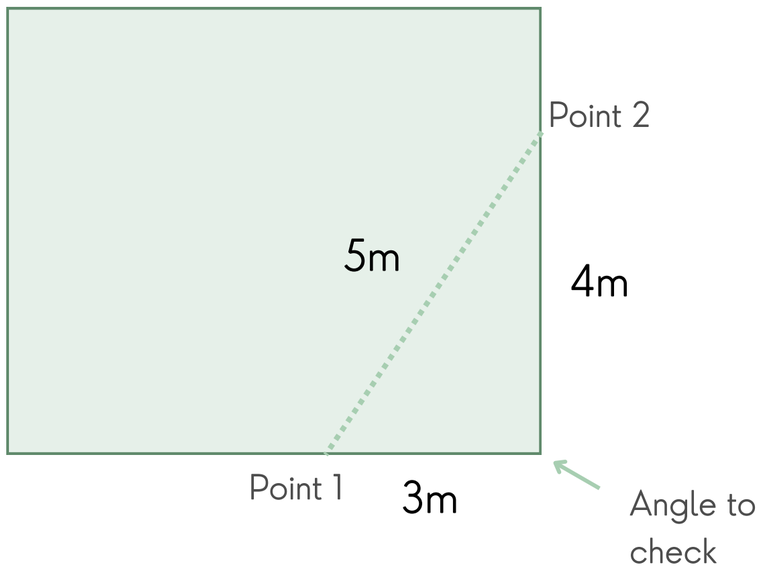
2. **Clear and level the site** : Remove vegetation, debris, and any obstacles that could interfere with marking out the foundation.

3. **Start from one corner** : This will serve as the starting point and main reference for all subsequent measurements.

4. **Mark the overall dimensions** of the building : Use stakes and string lines to outline the footprint according to your plans.

5. **Create a 90° corner** using the Pythagorean rule (3-4-5 method) : Measure 3 units on one side, 4 on the other, and adjust until the diagonal between them measures 5 units : ensuring a perfect right angle.

FOUNDATION TEAM



52 = 32 + 42

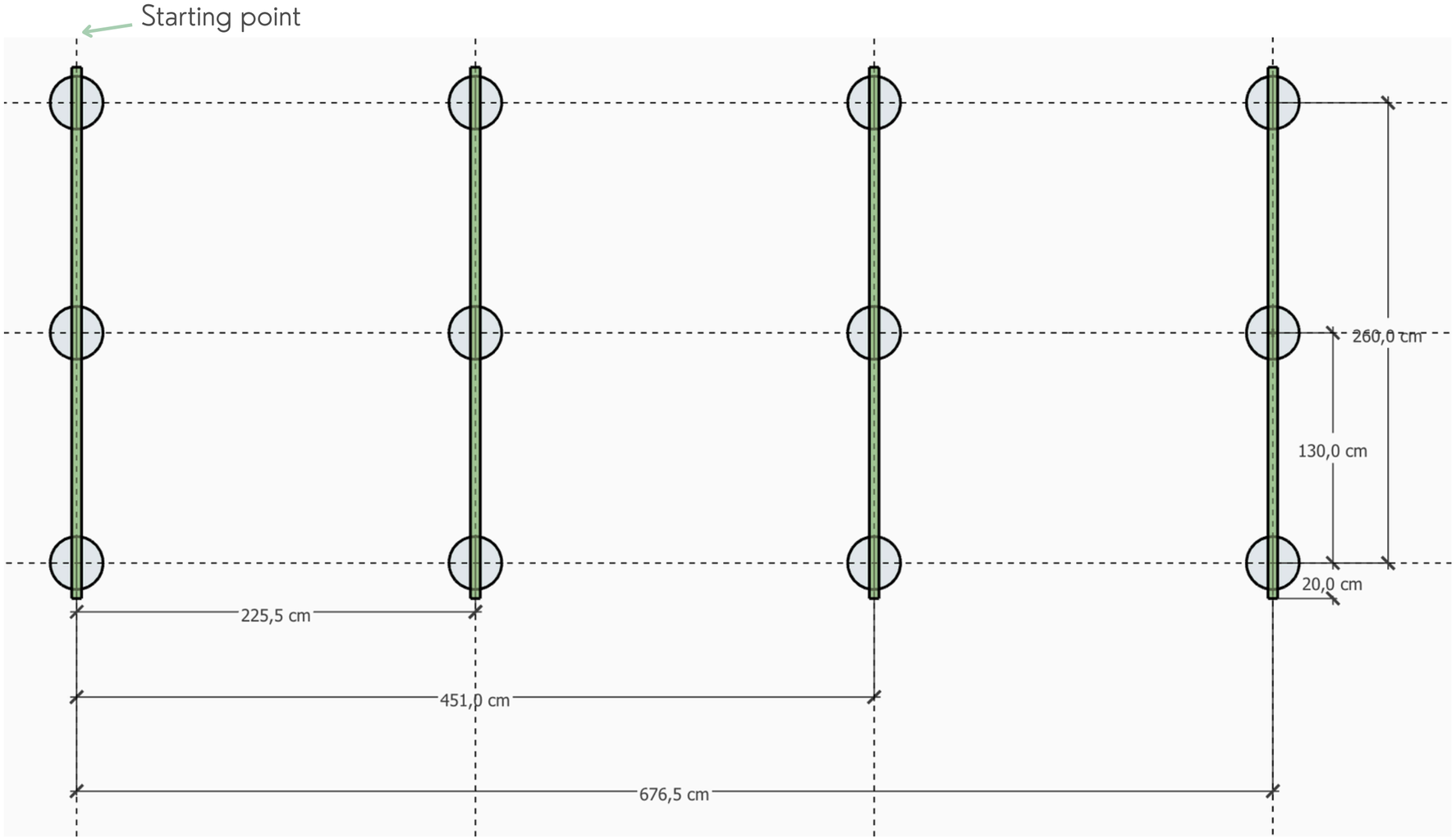
25 = 9 + 16 → ok !

This dimensions are just to calculate the 90 degree angle but have nothing to do with the dimensions of the building. You can adapt to your dimensions, but always using Pythagoras formula.



FOUNDATION TEAM

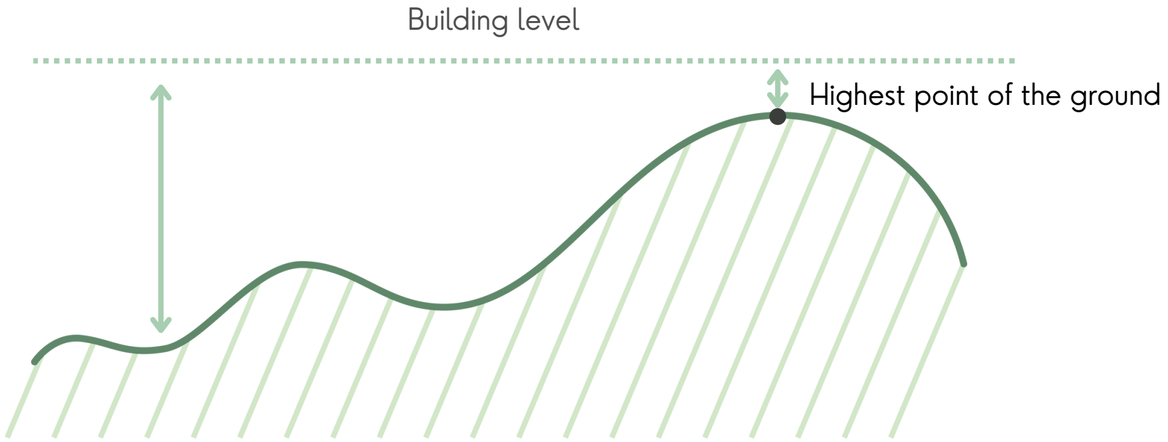
- Make the axis for the foundations.
- You should take the parallels from the 2 lines that make a corner in 90 degrees

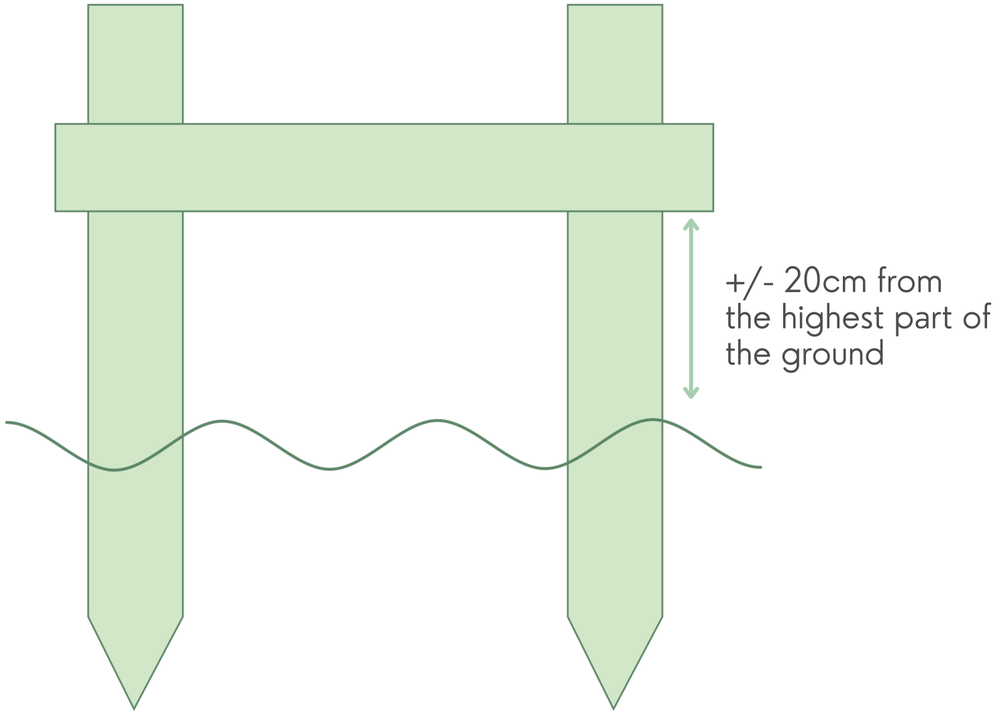


FOUNDATION TEAM

LEVELING

- Choose a starting point that will be the reference of the level of the building.
- It should be taken from the highest point of the ground
- This level can be the 0 (reference point) in terms hight for the building. This will be used until the end of the construction. (for example, the window can be at +30 from this point, but the floor at -20 from this point). You can choose the level, in this case we placed it around 20 cm from the highest point of the ground.
- The idea is to have an horizontal line that will guide us though the whole process.





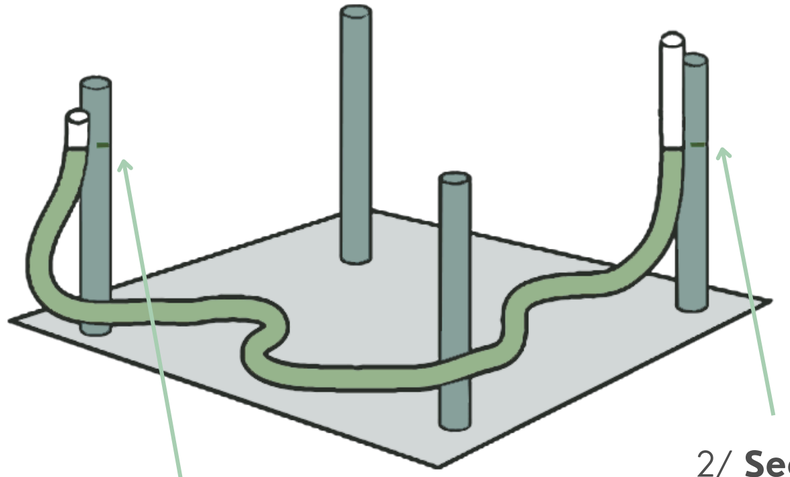
HOW TO MEASURE THE LEVEL IF YOU DON'T HAVE A LASER?

Usage tip

When it is necessary to measure levels over very long distances, an alternative method can be used:

- Pre-fill a transparent hose with water, equipped with graduated supports at both ends;
- Make sure there are no air bubbles in the hose and that it is not bent or twisted, as this could block the flow of water;
- Thanks to the principle of communicating vessels, the water level will be identical at both ends, the pressure allows the water to move freely and ensures proper leveling.

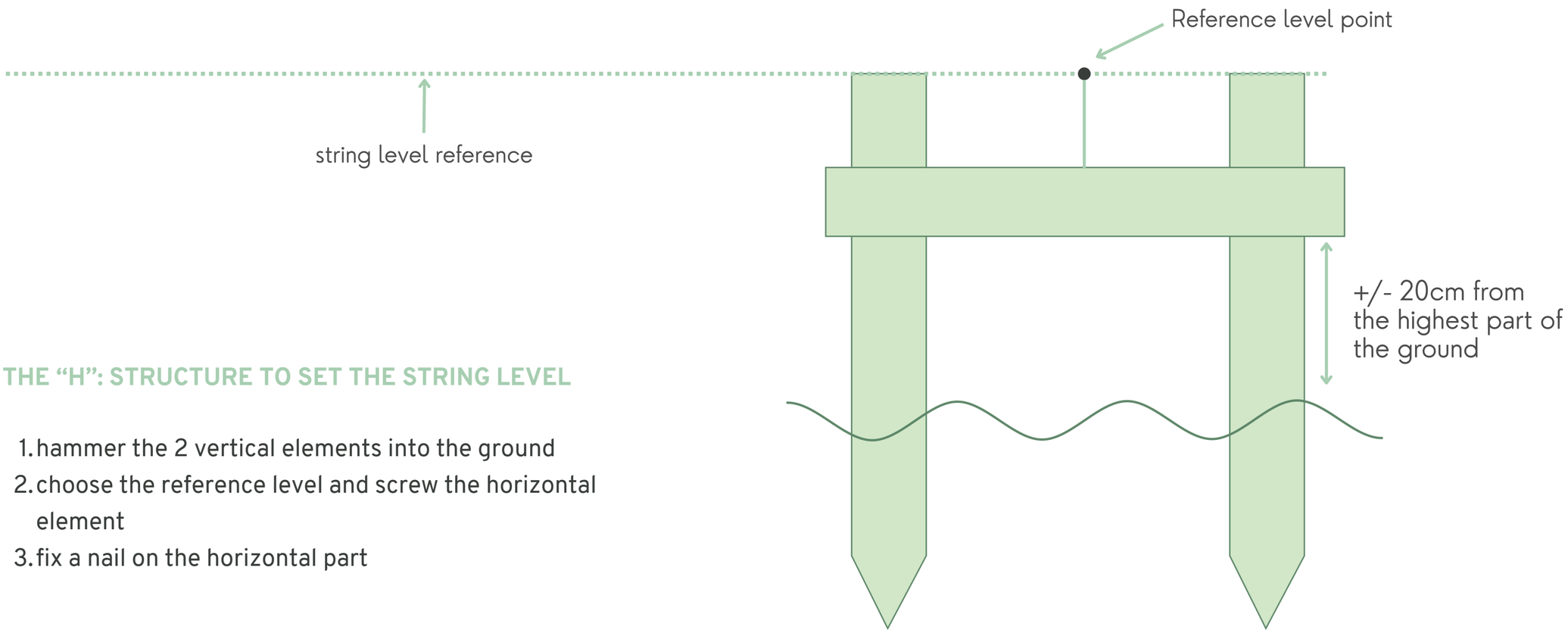
> ***The leveling method based on communicating vessels works by bringing the water level to the reference point (1), then marking the point (2) where the water settles at the desired location.***



1/ **First reference level:** the water should reach this mark during installation.

2/ **Second level** to be marked: corresponds to the point where the water reaches.

FOUNDATION TEAM

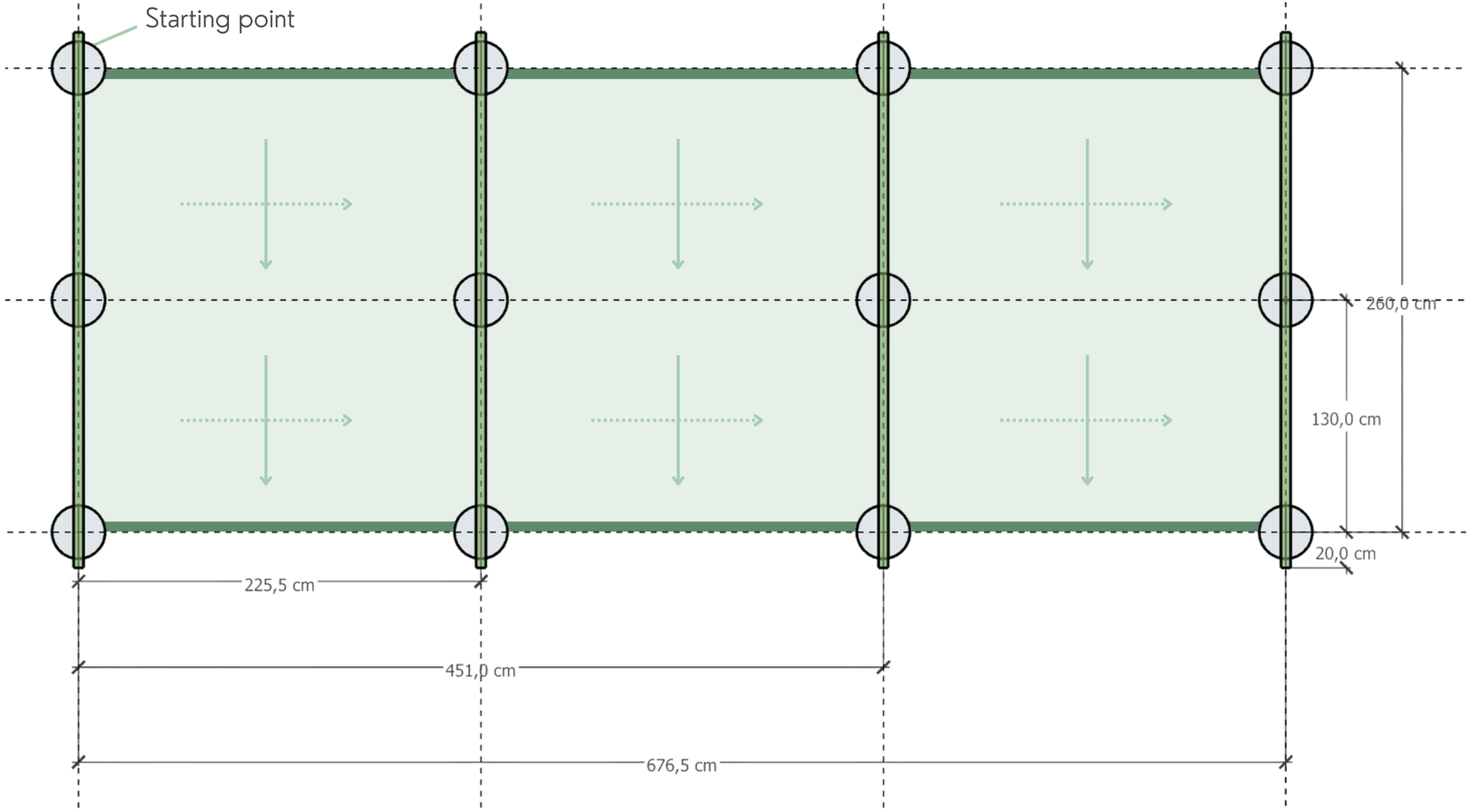


THE “H”: STRUCTURE TO SET THE STRING LEVEL

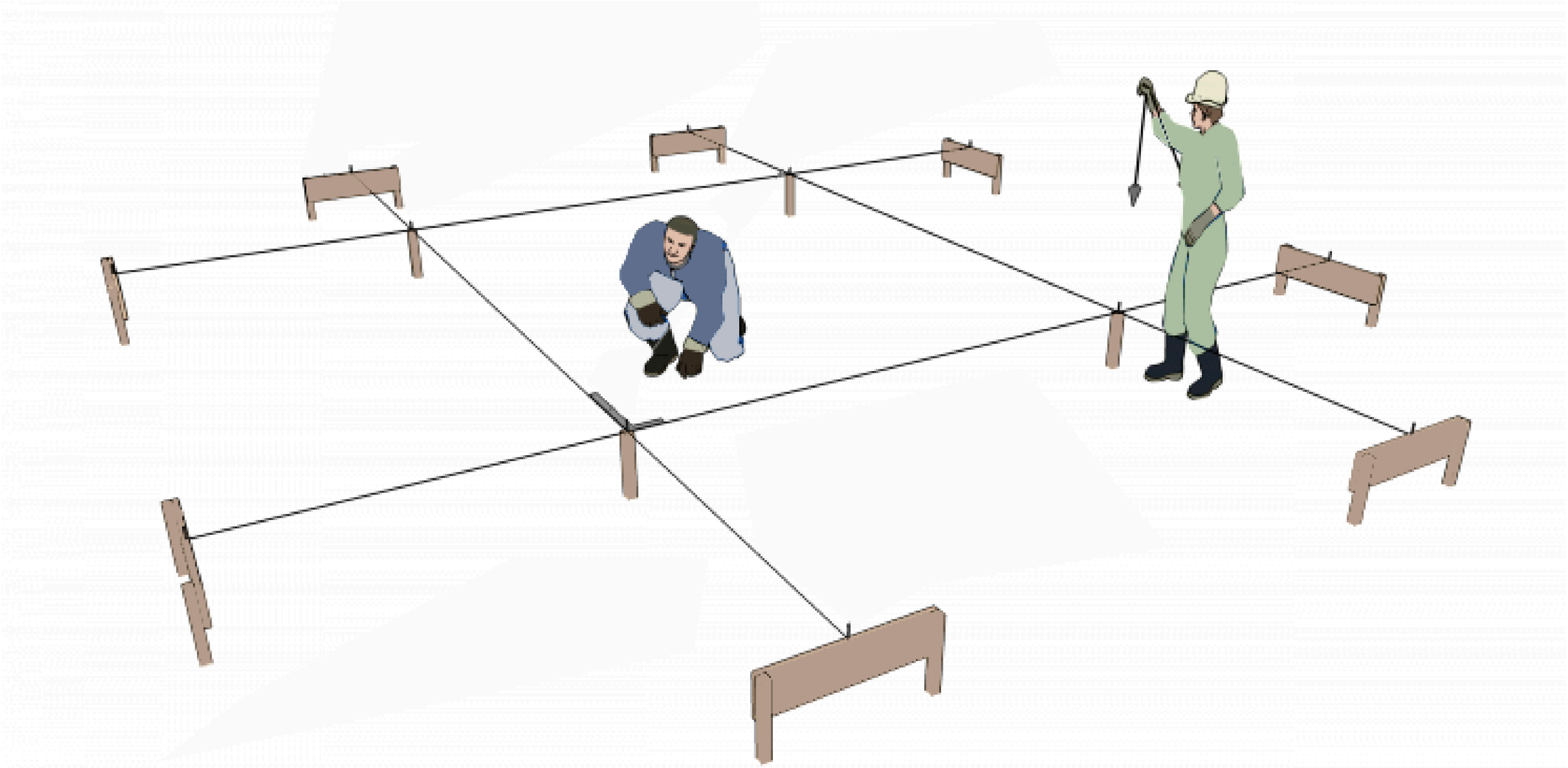
1. hammer the 2 vertical elements into the ground
2. choose the reference level and screw the horizontal element
3. fix a nail on the horizontal part

FOUNDATION TEAM

POSITION OF THE FOUNDATIONS



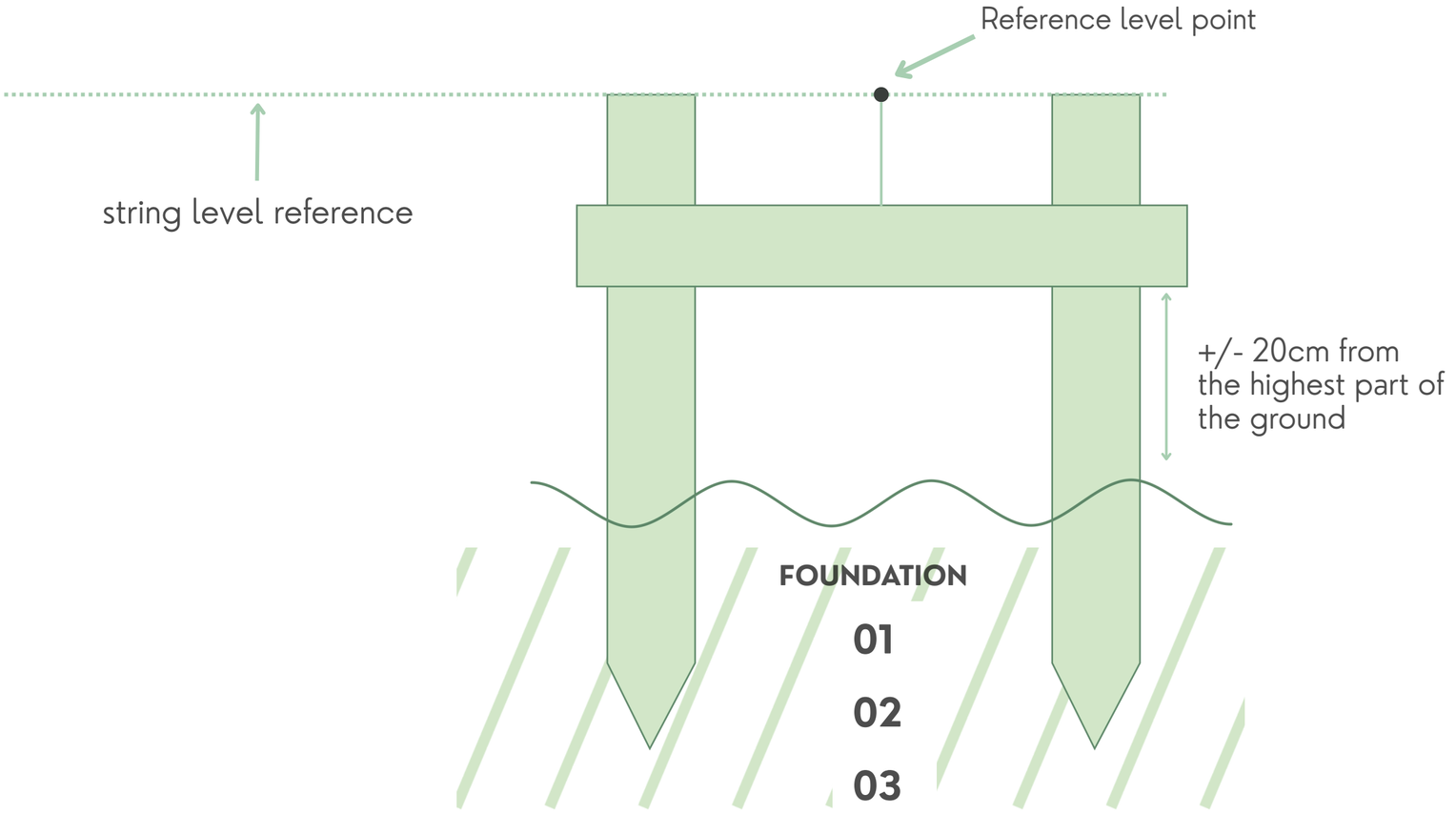
FOUNDATION TEAM



FOUNDATION TEAM

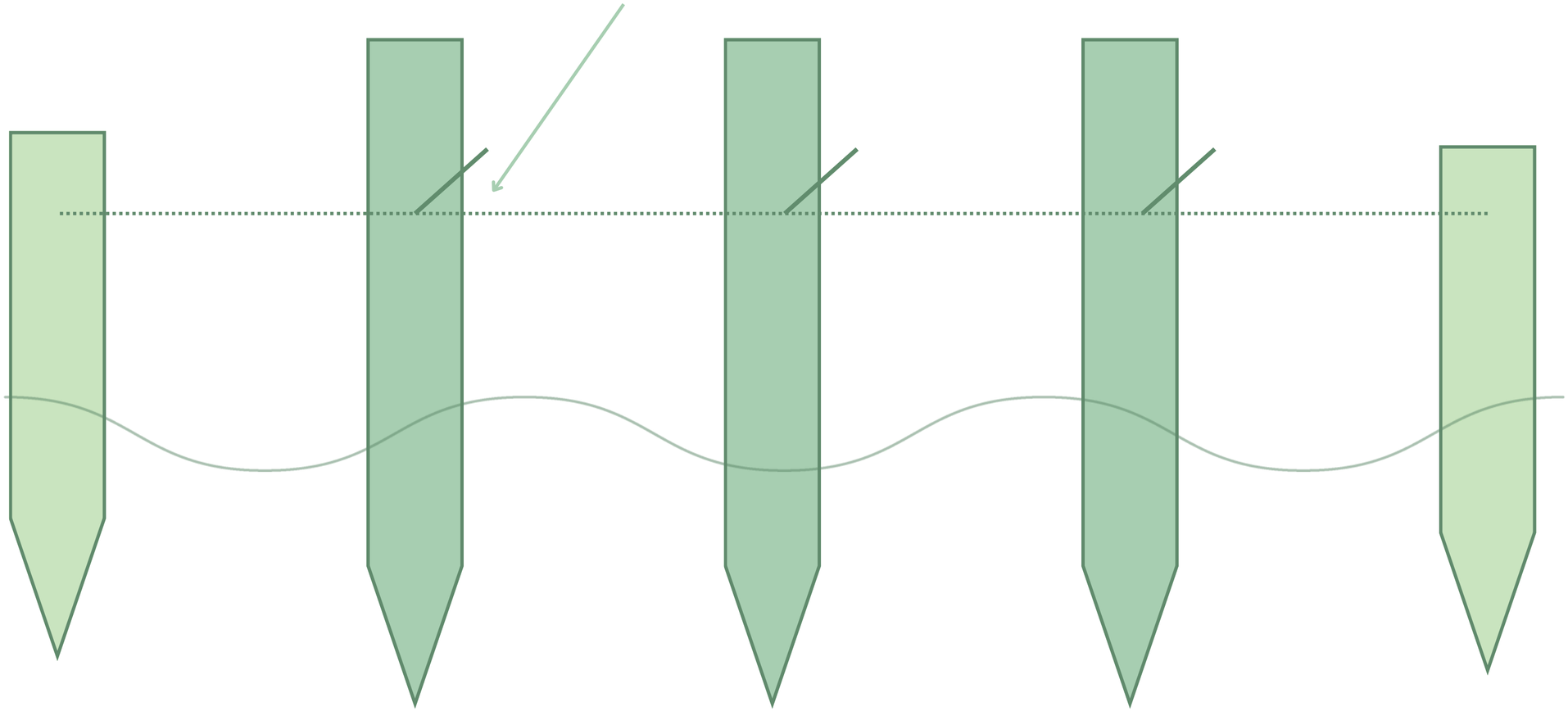






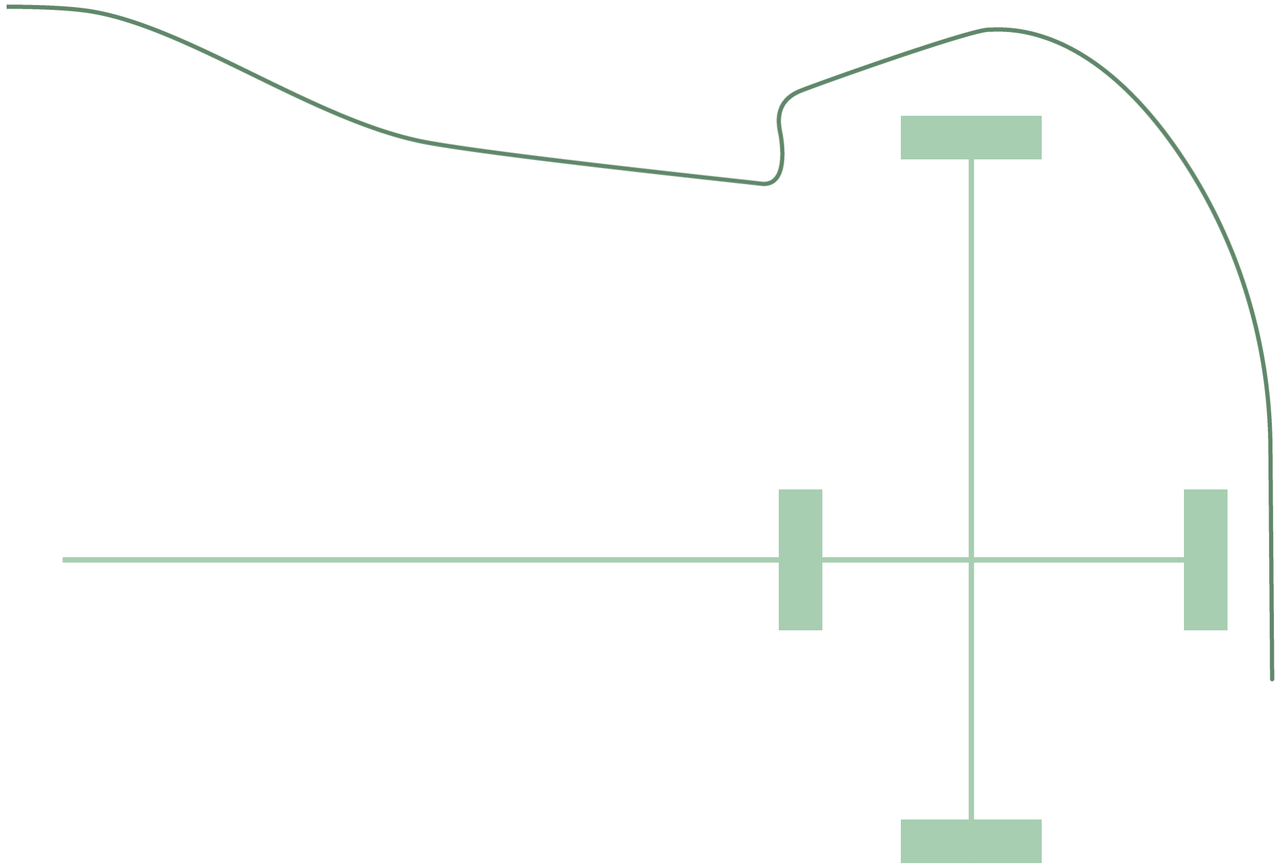
FOUNDATION TEAM

the 3 pilars are the position of the stones, and the level of the woodden floor (bottom part)



FOUNDATION TEAM

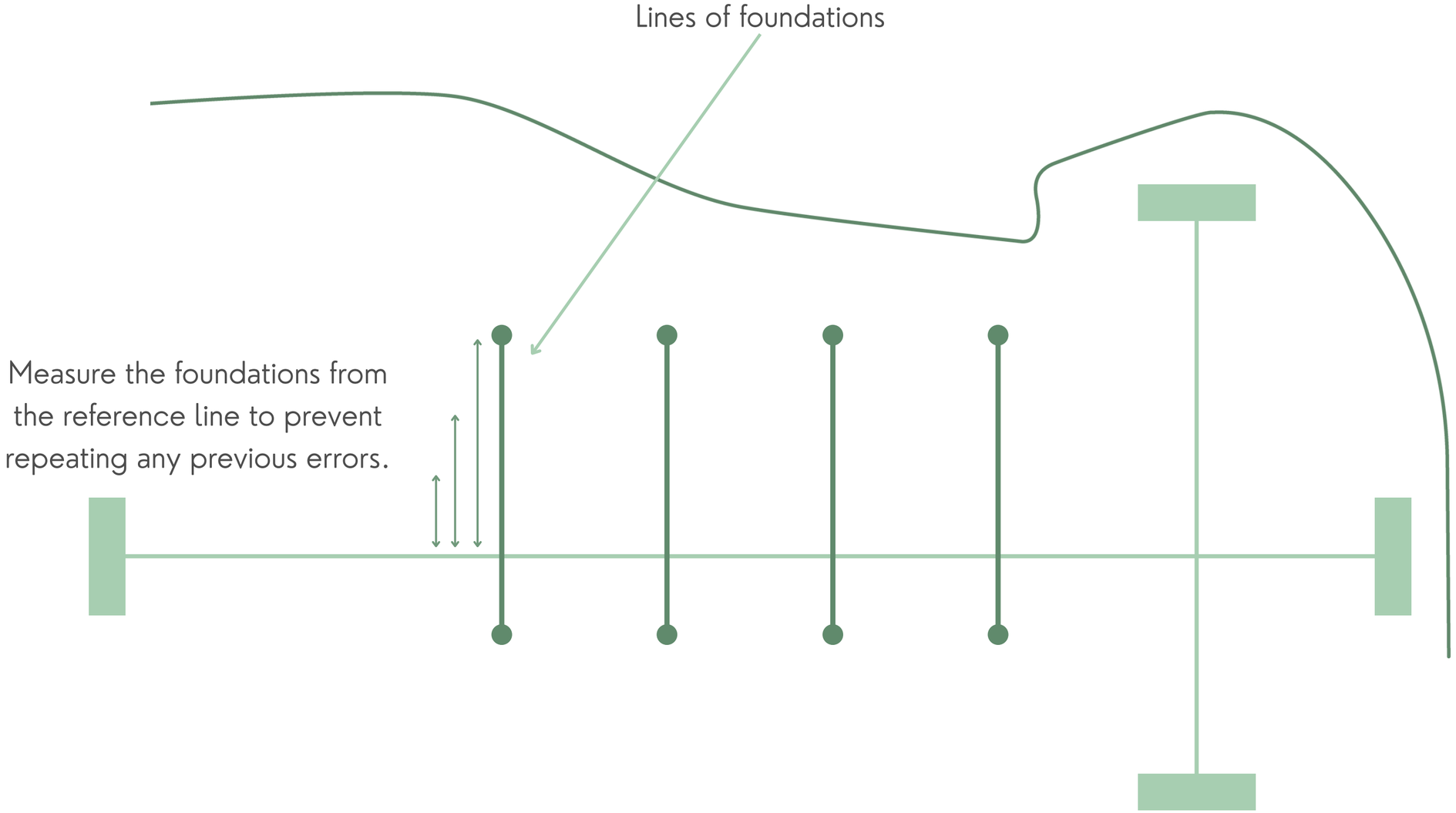
Put a string and repeat the action 4 times





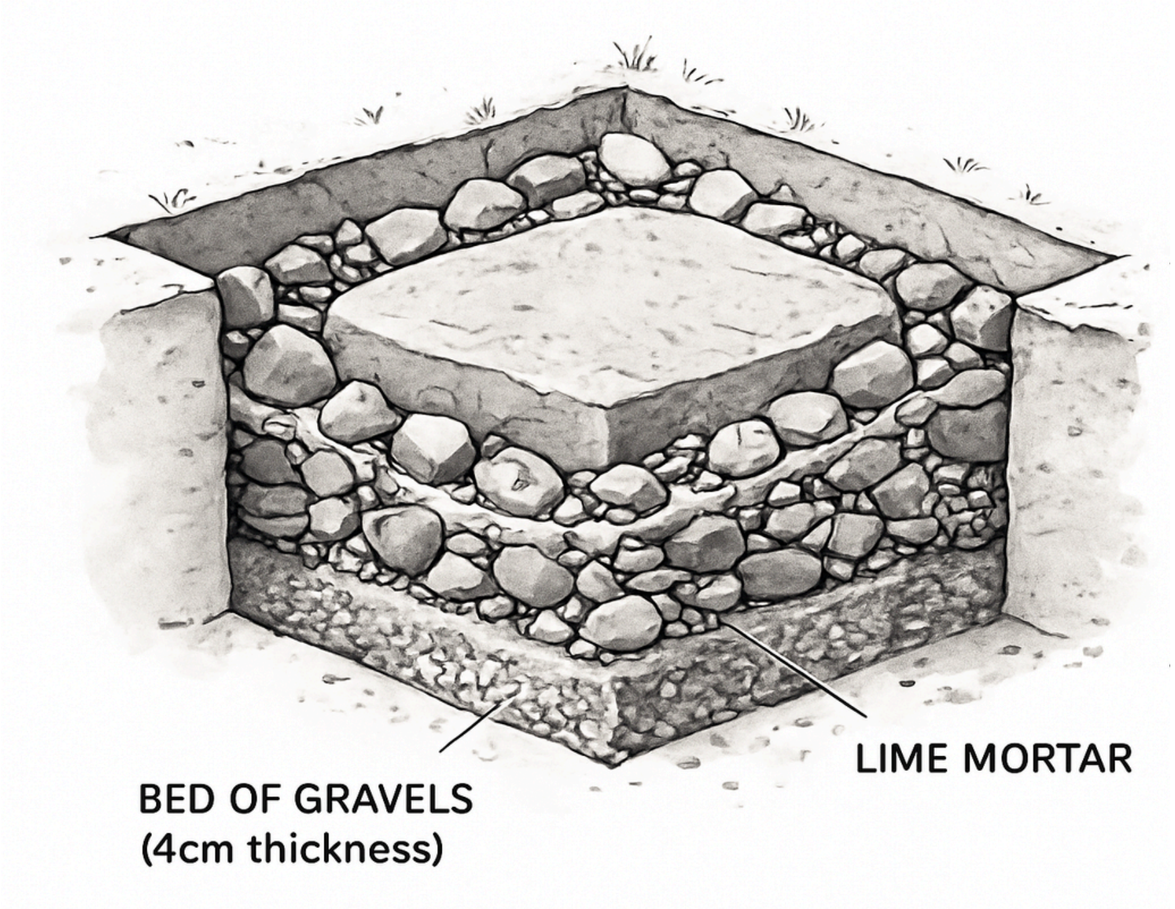
FOUNDATION TEAM

Put a string and repeat the action 4 times



FOUNDATION TEAM

1. Go to choose stones - bring them
2. Mark the holes on the ground
3. Dig the holes
    a. shovels, gloves
4. *If needed : prepare a flat surface on the stone to prepare the top level*
5. Bed of gravels (4cm thickness) in the bottom of the holes
6. Compact the gravels
7. Second layer : prepare a mix of lime mortar (1 vol. hydraulic lime + 3 vol. sand)
    a. *buckets*
    b. *mixer/shovels*
    c. *gloves*
    d. *wheelbarrow*
8. Put the stones and mortar in the hole, and the big stone. fill all the free spaces with little stones and lime mortar.
9. The floor has to be minimum 20cm from the ground.



T2.
CUTTING TEAM





CUTTING TEAM

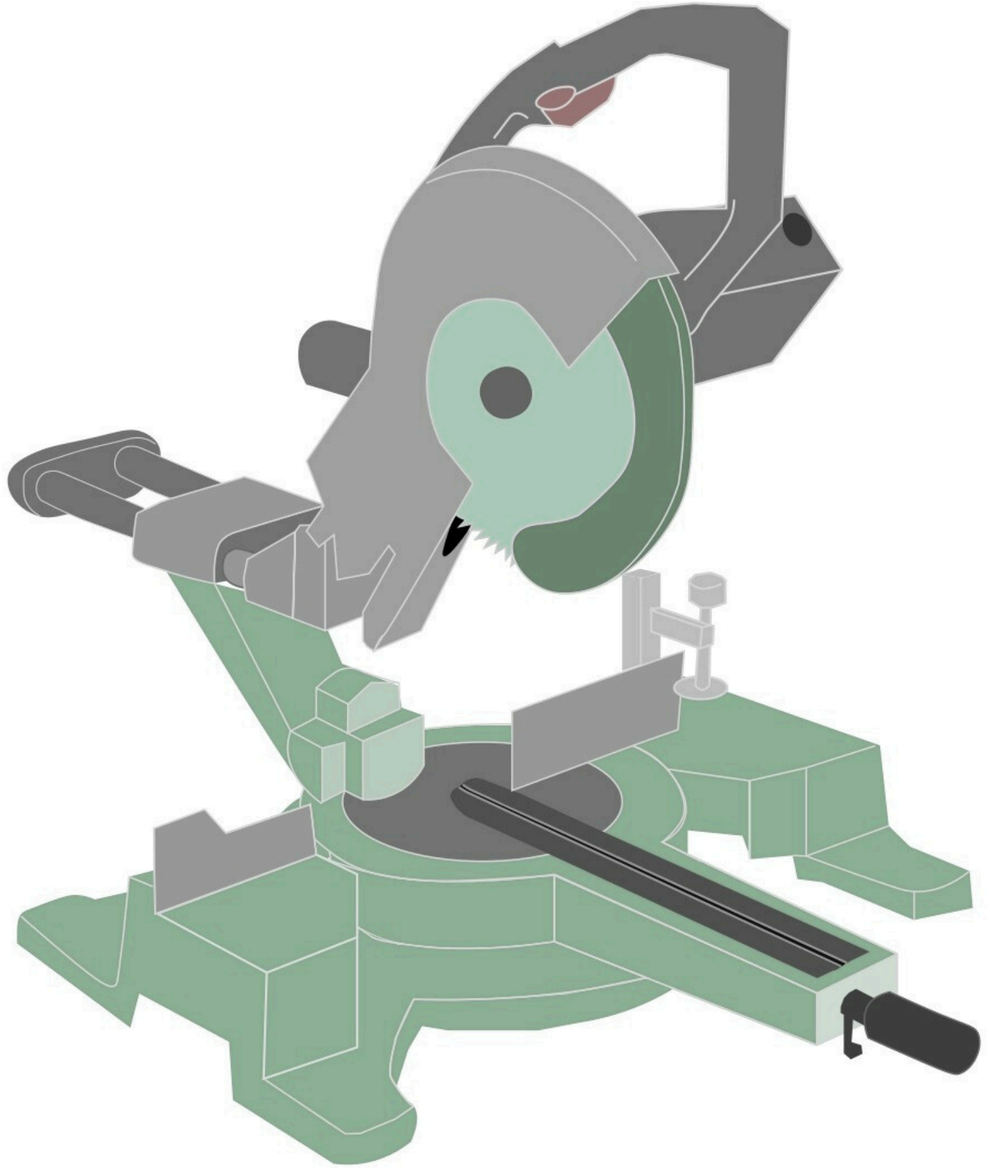
To cut the wood, we used **a miter saw**, which is the best and safest tool for making repeated cuts in these materials.

We started by **creating a general cut list**, then organized the cuts to minimize wood waste and optimize the use of available lengths.

When cutting with the saw, it's important to **account for the blade thickness**, about 3 mm, and to mark the cut line precisely depending on which side of the mark you want to keep.

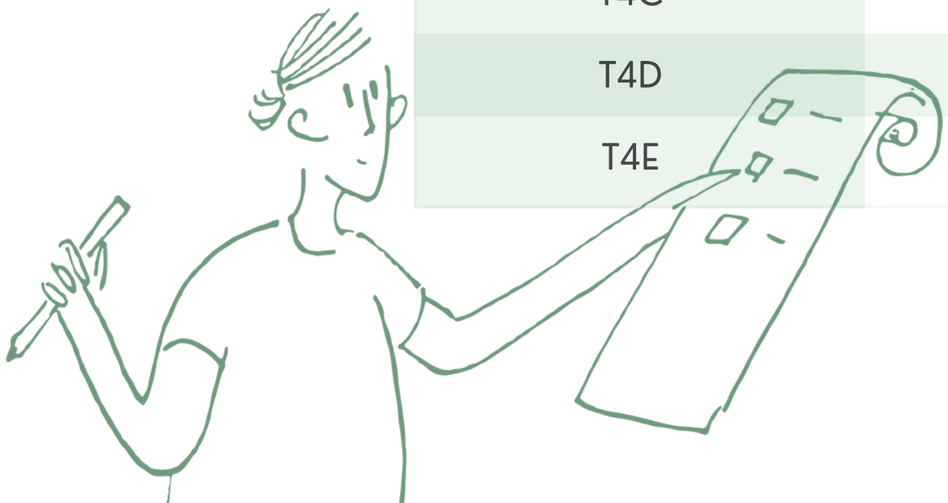
CUTTING TEAM

1. Install a cutting station : stable, long enough
2. Bring the wood beams
3. Read the plans, cut the wood
4. Mitter saw, gloves, goggles, hear protection, meter, Square, pencil (cutter)
5. Put the name on every beam
6. Sort the beams by name



CUTTING TEAM

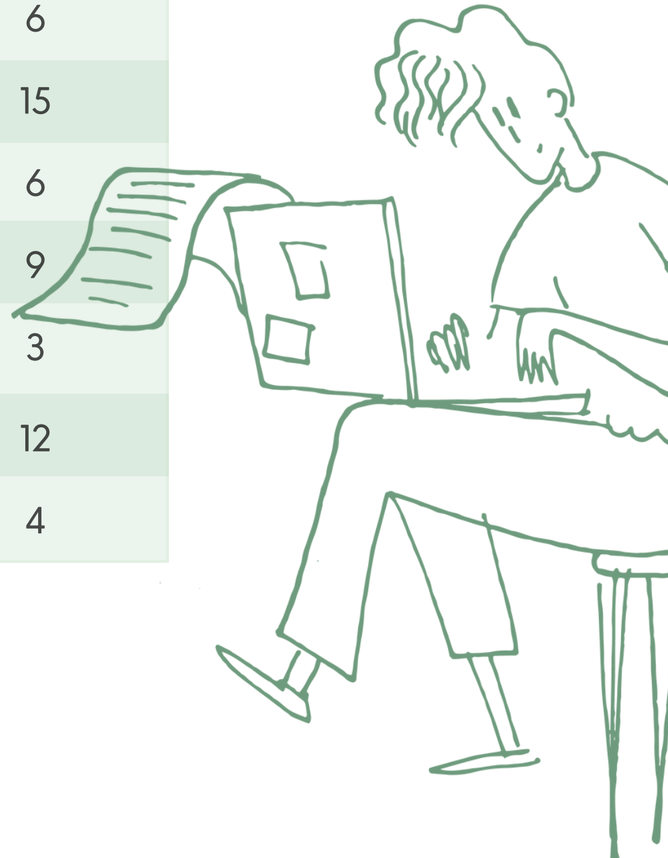
Name of the beam	Team	Lenght	Section	Amount
T3A	T3	300	55/120	4
T3B	T3	220	55/120	12
T3C	T3	300	22/120	4
T3D	T3	300	12/120	30
T4A	T4	273.9	65/120	4
T4B	T4	238	55/120	4
T4C	T4	315.5	65/120	4
T4D	T4	277.9	55/120	4
T4E	T4	460	55/120	8



CUTTING TEAM

Dictionary of codes :
HF : High facade
LF : Low facade
SW : Side wall

Name of the beam	Team	Lenght	Section	Amount
T5.HF.A	T5	307.1	65/42	15
T5.HF.B	T5	215.8	65/42	6
T5.HF.C	T5	55.8	65/42	6
T5.LF.A	T5	265.7	65/42	15
T5.LF.B	T5	215.8	65/42	6
T5.LF.C	T5	90	65/42	9
T5.LF.D	T5	31.6	65/42	3
T5.SW.A	T5	231.2	65/42	12
T5.SW.B	T5	276	65/420	4



CUTTING TEAM

OPTIMISATION OF CUTS :

- **Board 1:** T3A 300 + T3A 300 → used 600.0 cm, waste 0.0 cm
- **Board 2:** T3A 300 + T3A 300 → used 600.0 cm, waste 0.0 cm
- **Board 3:** T4D 277.9 + T4D 277.9 → used 555.8 cm, waste 44.2 cm
- **Board 4:** T4D 277.9 + T4D 277.9 → used 555.8 cm, waste 44.2 cm
- **Board 5:** T4B 238 + T4B 238 → used 476.0 cm, waste 124.0 cm
- **Board 6:** T4B 238 + T4B 238 → used 476.0 cm, waste 124.0 cm
- **Board 7:** T4E 460 → used 460.0 cm, waste 140.0 cm
- **Board 8:** T4E 460 → used 460.0 cm, waste 140.0 cm
- **Board 9:** T4E 460 → used 460.0 cm, waste 140.0 cm
- **Board 10:** T4E 460 → used 460.0 cm, waste 140.0 cm
- **Board 11:** T4E 460 → used 460.0 cm, waste 140.0 cm
- **Board 12:** T4E 460 → used 460.0 cm, waste 140.0 cm
- **Board 13:** T4E 460 → used 460.0 cm, waste 140.0 cm
- **Board 14:** T4E 460 → used 460.0 cm, waste 140.0 cm
- **Board 15:** T3B 220 + T3B 220 → used 440.0 cm, waste 160.0 cm
- **Board 16:** T3B 220 + T3B 220 → used 440.0 cm, waste 160.0 cm
- **Board 17:** T3B 220 + T3B 220 → used 440.0 cm, waste 160.0 cm
- **Board 18:** T3B 220 + T3B 220 → used 440.0 cm, waste 160.0 cm
- **Board 19:** T3B 220 + T3B 220 → used 440.0 cm, waste 160.0 cm
- **Board 20:** T3B 220 + T3B 220 → used 440.0 cm, waste 160.0 cm

SECTION
→ 55/120



CUTTING TEAM

- **Board 1:** T4C 315.5 + T5.SW.B 276.0 → used 591.8 cm, waste 8.2 cm
- **Board 2:** T4C 315.5 + T5.SW.B 276.0 → used 591.8 cm, waste 8.2 cm
- **Board 3:** T4C 315.5 + T5.SW.B 276.0 → used 591.8 cm, waste 8.2 cm
- **Board 4:** T4C 315.5 + T5.SW.B 276.0 → used 591.8 cm, waste 8.2 cm
- **Board 5:** T5.HF.A 307.1 + T4A 273.9 → used 581.3 cm, waste 18.7 cm
- **Board 6:** T5.HF.A 307.1 + T4A 273.9 → used 581.3 cm, waste 18.7 cm
- **Board 7:** T5.HF.A 307.1 + T4A 273.9 → used 581.3 cm, waste 18.7 cm
- **Board 8:** T5.HF.A 307.1 + T4A 273.9 → used 581.3 cm, waste 18.7 cm
- **Board 9:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm
- **Board 10:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm
- **Board 11:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm
- **Board 12:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm
- **Board 13:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm
- **Board 14:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm
- **Board 15:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm
- **Board 16:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm
- **Board 17:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm
- **Board 18:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm
- **Board 19:** T5.HF.A 307.1 + T5.LF.A 265.7 → used 573.1 cm, waste 26.9 cm

SECTION
→ 65/42



CUTTING TEAM

- **Board 20:** T5.LF.A 265.7 + T5.LF.A 265.7 + T5.HF.C 55.8 → used 587.8 cm, waste 12.2 cm
- **Board 21:** T5.LF.A 265.7 + T5.LF.A 265.7 + T5.HF.C 55.8 → used 587.8 cm, waste 12.2 cm
- **Board 22:** T5.SW.A 231.2 + T5.SW.A 231.2 + T5.LF.C 90.0 + T5.LF.D 31.6 → used 584.9 cm, waste 15.1 cm
- **Board 23:** T5.SW.A 231.2 + T5.SW.A 231.2 + T5.LF.C 90.0 + T5.LF.D 31.6 → used 584.9 cm, waste 15.1 cm
- **Board 24:** T5.SW.A 231.2 + T5.SW.A 231.2 + T5.LF.C 90.0 + T5.LF.D 31.6 → used 584.9 cm, waste 15.1 cm
- **Board 25:** T5.SW.A 231.2 + T5.SW.A 231.2 + T5.LF.C 90.0 → used 553.0 cm, waste 47.0 cm
- **Board 26:** T5.SW.A 231.2 + T5.SW.A 231.2 + T5.LF.C 90.0 → used 553.0 cm, waste 47.0 cm
- **Board 27:** T5.SW.A 231.2 + T5.SW.A 231.2 + T5.LF.C 90.0 → used 553.0 cm, waste 47.0 cm
- **Board 28:** T5.HF.B 215.8 + T5.HF.B 215.8 + T5.LF.C 90.0 + T5.HF.C 55.8 → used 578.3 cm, waste 21.7 cm
- **Board 29:** T5.HF.B 215.8 + T5.HF.B 215.8 + T5.LF.C 90.0 + T5.HF.C 55.8 → used 578.3 cm, waste 21.7 cm
- **Board 30:** T5.HF.B 215.8 + T5.HF.B 215.8 + T5.LF.C 90.0 + T5.HF.C 55.8 → used 578.3 cm, waste 21.7 cm
- **Board 31:** T5.LF.B 215.8 + T5.LF.B 215.8 + T5.HF.C 55.8 → used 488.0 cm, waste 112.0 cm
- **Board 32:** T5.LF.B 215.8 + T5.LF.B 215.8 → used 431.9 cm, waste 168.1 cm
- **Board 33:** T5.LF.B 215.8 + T5.LF.B 215.8 → used 431.9 cm, waste 168.1 cm

SECTION
→ 65/42

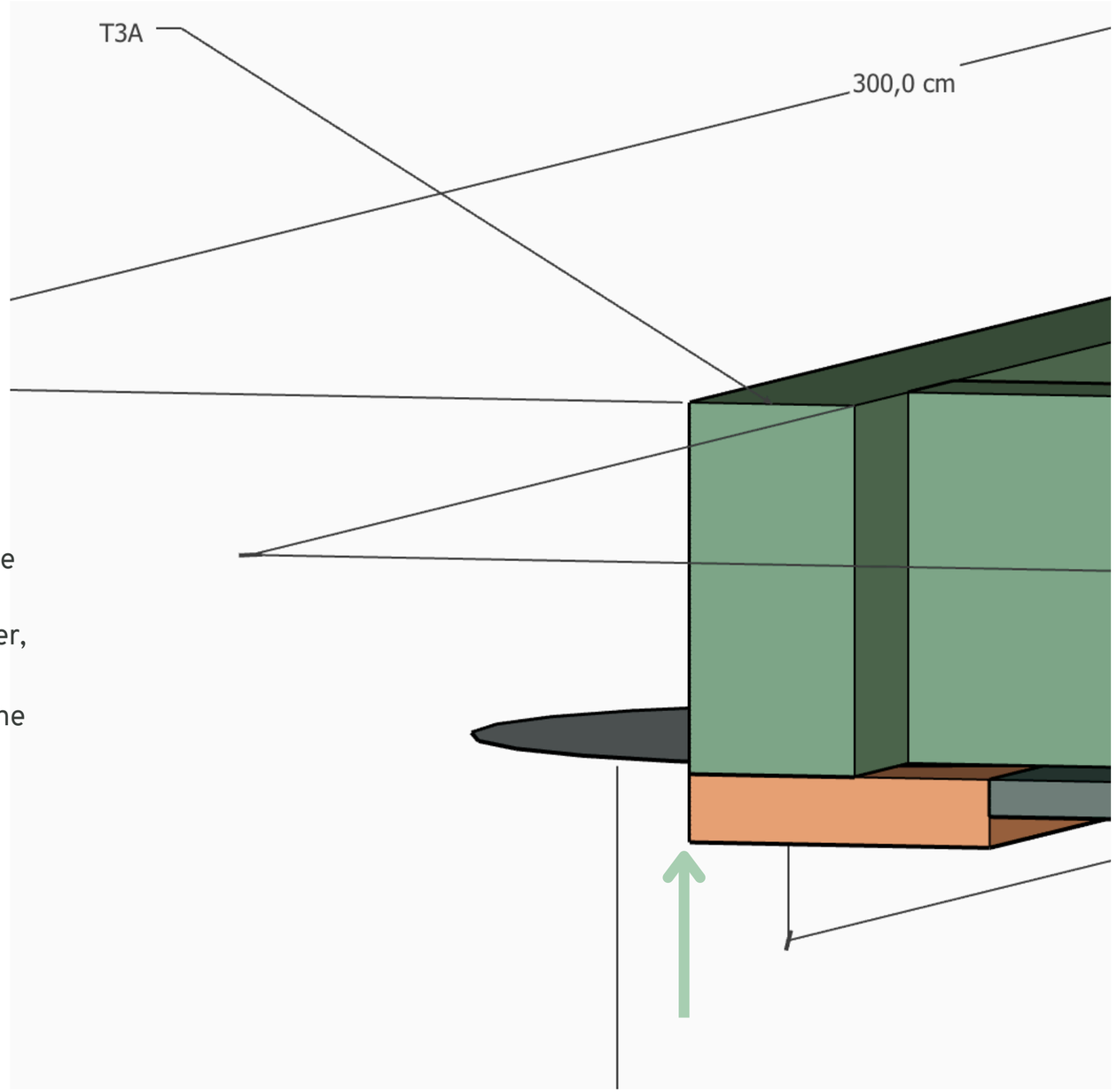


T3.
FLOOR TEAM



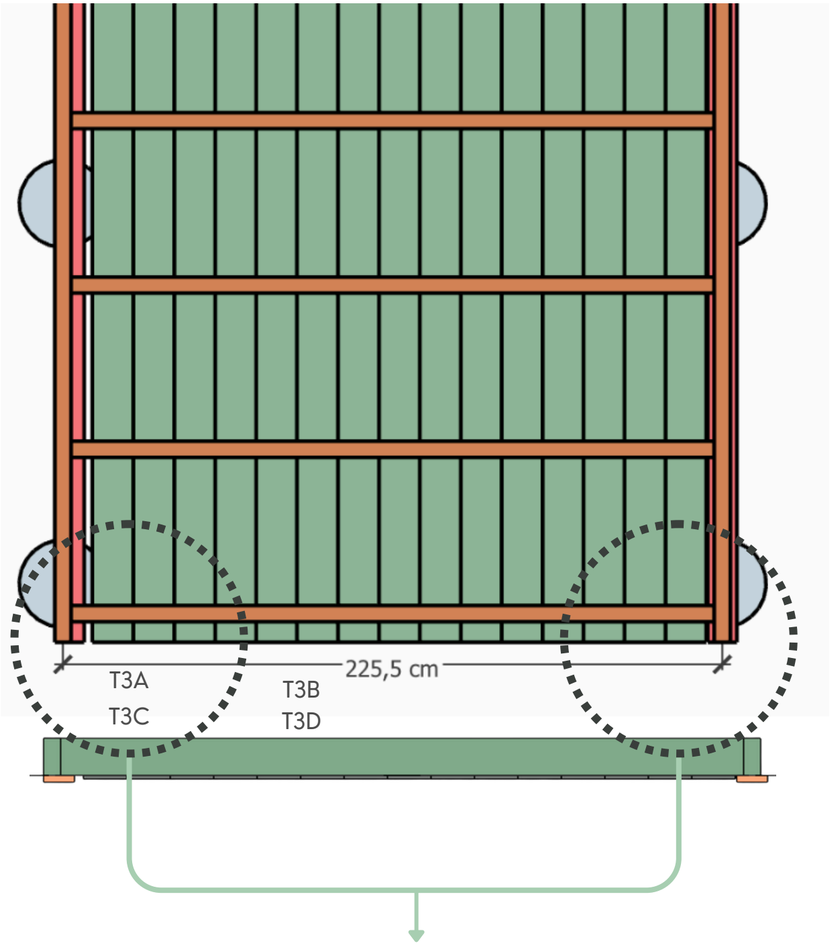
FLOOR TEAM

1. Assemble the beams (T3A,T3C)
2. The plank (in pink on the image) allows to align the future beams, to facilitate the process.
    a. Tools : glue and clamps, screwdriver, pencil, meter,
    b. Screws (5x70):
        i. one screw every 40cm. Starting 15cm from the end of the beam)





FLOOR TEAM



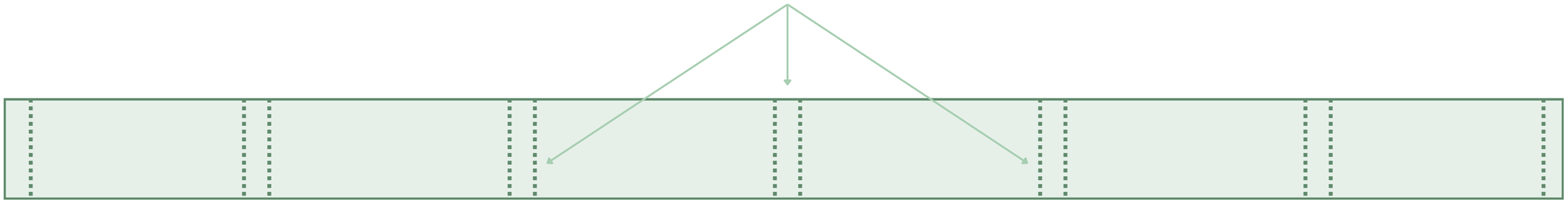
Be careful, the planks under the beams have a different position

FLOOR TEAM

1. Make sure you have a flat surface to work : +/- 4x4 meters
2. Assemble the structure together (T3A-C, T3B)
    a. screws : 6x160
    b. tools : screwdriver, pencil, meter, clamps, hammer,
3. Place the planks (T3D)
    a. screws of 5x50

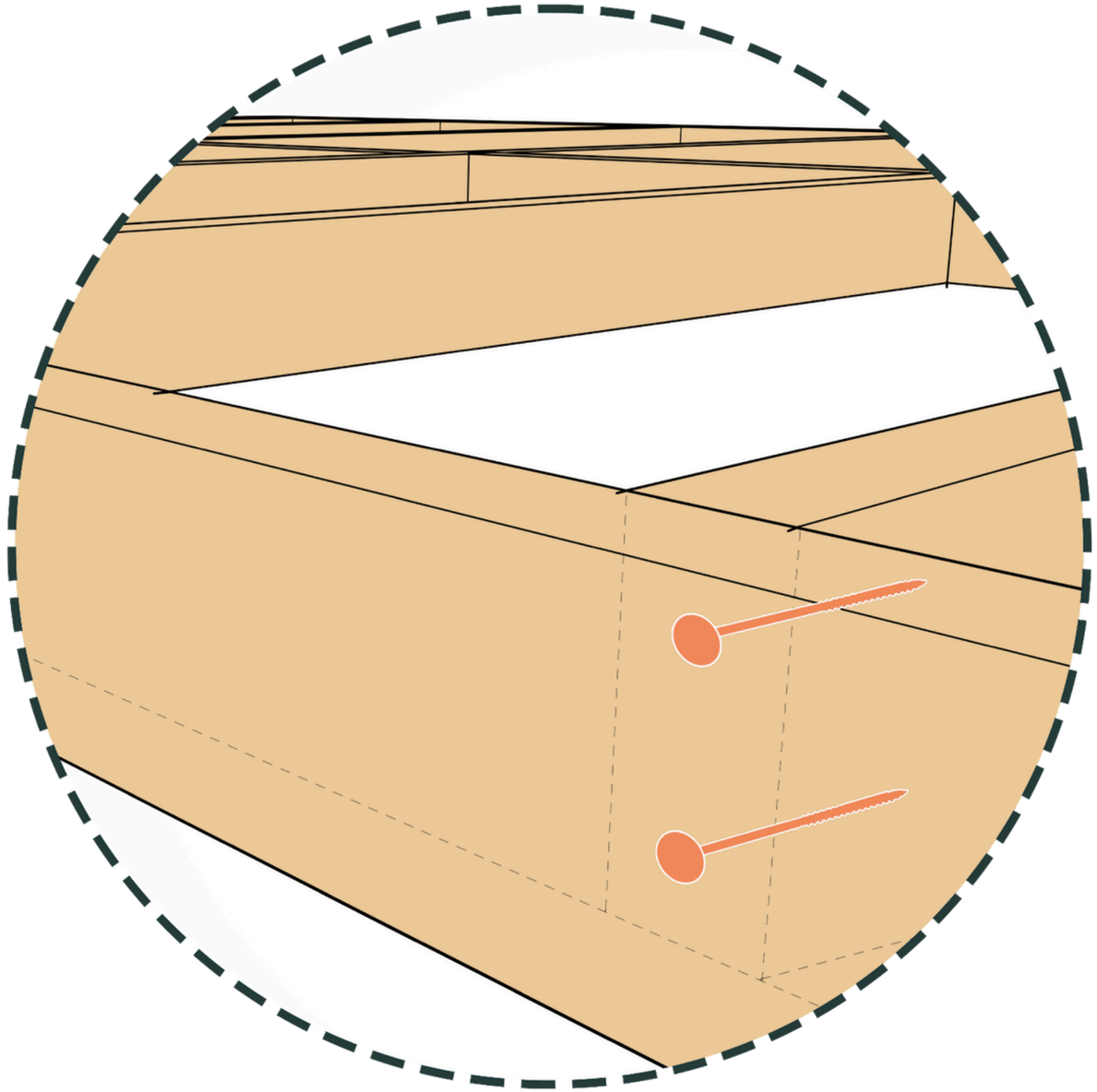
Tips :

- Be sure that you measure every mark from the same place
- Mark the place of the beam to make sure it’s straight



FLOOR TEAM

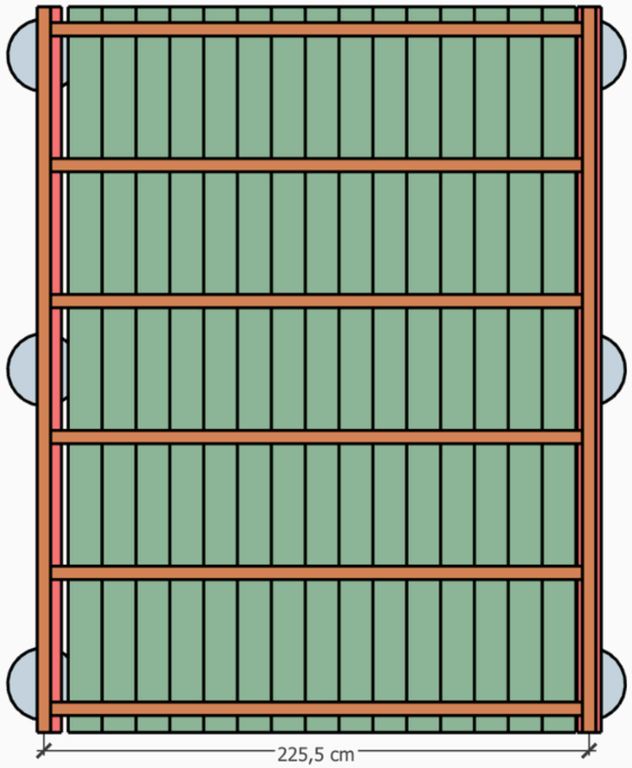
To screw : 2 screws of 6x160 on each beam

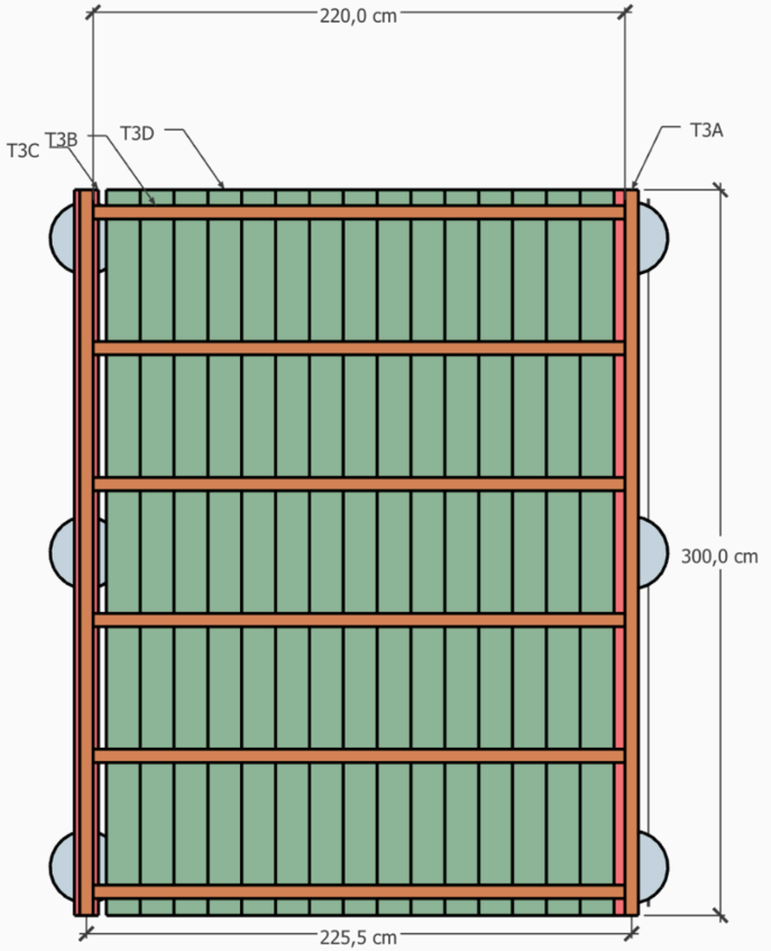


FLOOR TEAM

GENERAL FLOOR PLAN:

Start by assembling the two outside floors on the foundations. This will allow you to **take accurate measurements** for the intermediate floor and fit it precisely between the two slabs.

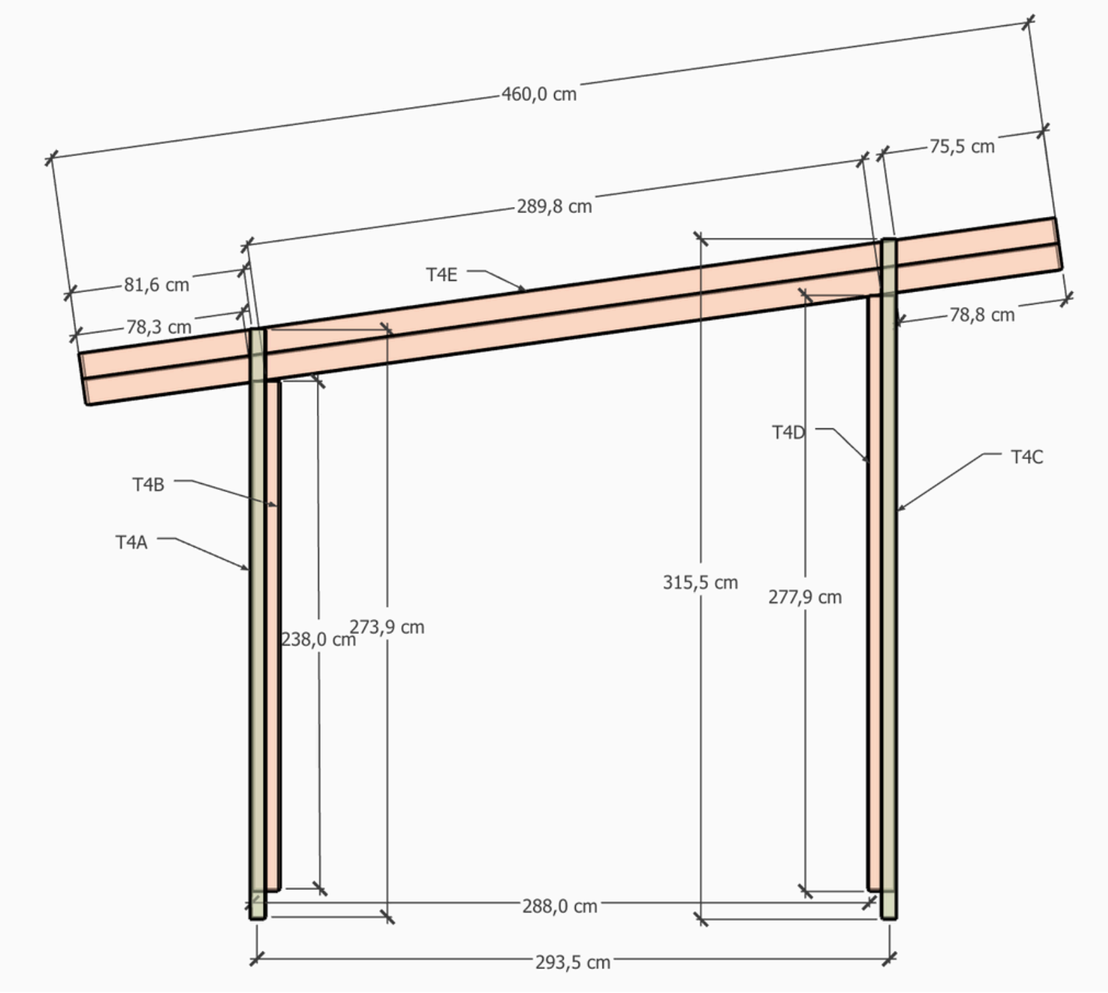




T4.
PORTICO TEAM



PORTICO TEAM



There are four porticos in total. Each one is built in exactly the same way. They are assembled to create strong anchors that can be placed directly on the floors.

PORTICO TEAM

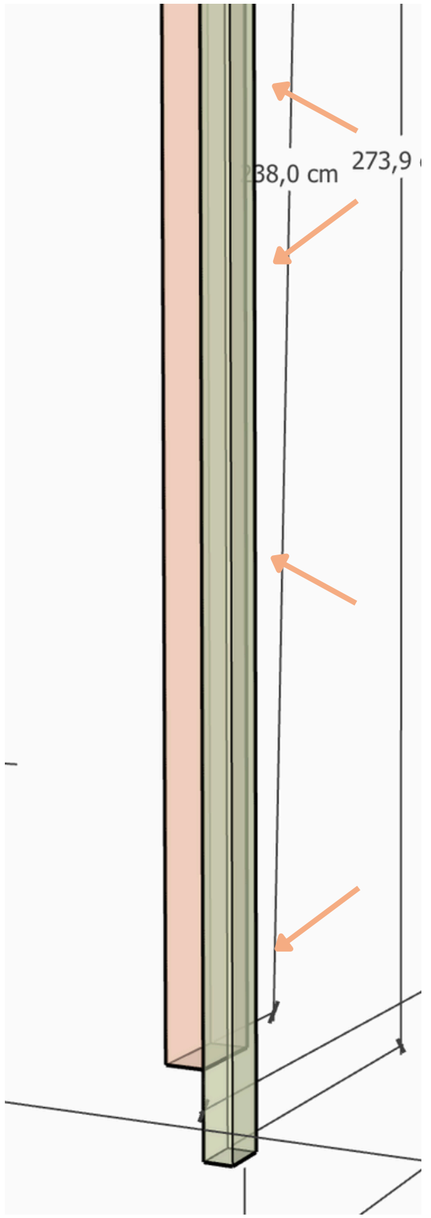
1 Assemble the pillars

a. Glue the two pillars
b. Screw in diagonal (screw of 6x120)
c. Tools : glue, wood for the glue, screwdriver, pencil, meter,

→ Distance of the **first screw** from the bottom 15 cm then one screw every 40 cm.

→ Distance between **the end of the shorter pillar and the end** of the longer one are :
12cm at the bottom (and 24cm at the top)

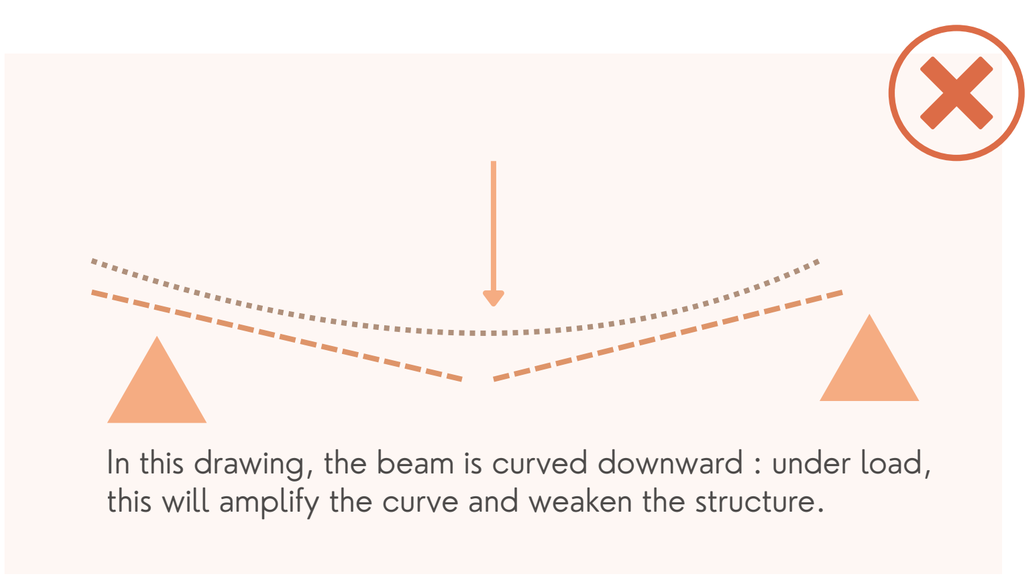
→ If the wood is curved, first make the edges fit and then clamp it on the middle while and screw it to uncurve it



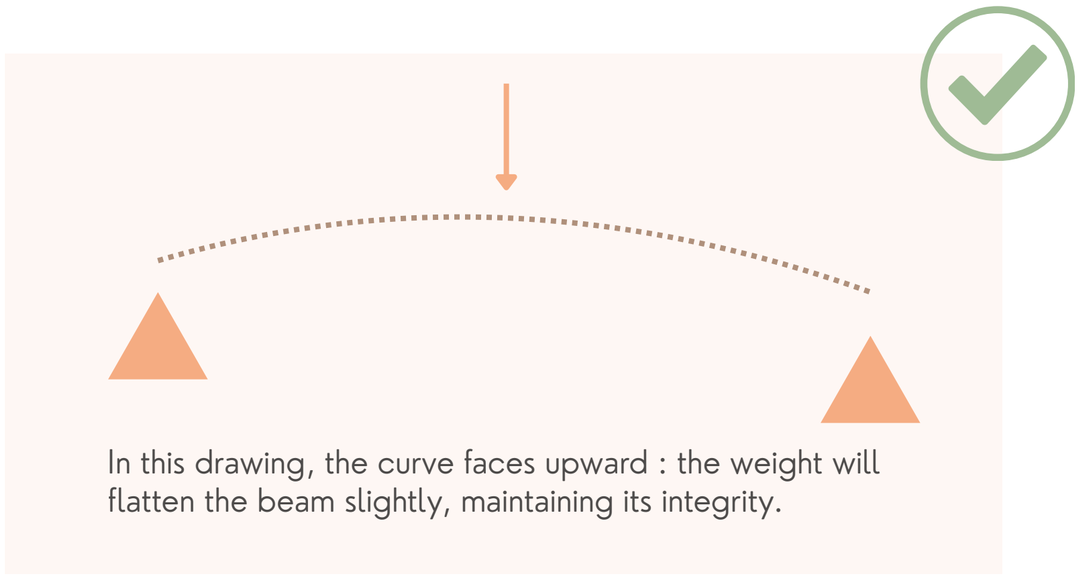
ASSEMBLE THE DOUBLE BEAM

Before assembling, **check the natural curve** of each beam. Sometimes, the wood fibers create a slight bend. It's important to identify this before fixing the beams together, as it affects the structural behavior.

If a beam has a natural curve, it's best to place it with **the curve facing upward** rather than downward. This way, when the structure bears weight, the load will help flatten the curve instead of increasing it, keeping the structure strong and stable.



In this drawing, the beam is curved downward : under load, this will amplify the curve and weaken the structure.



In this drawing, the curve faces upward : the weight will flatten the beam slightly, maintaining its integrity.

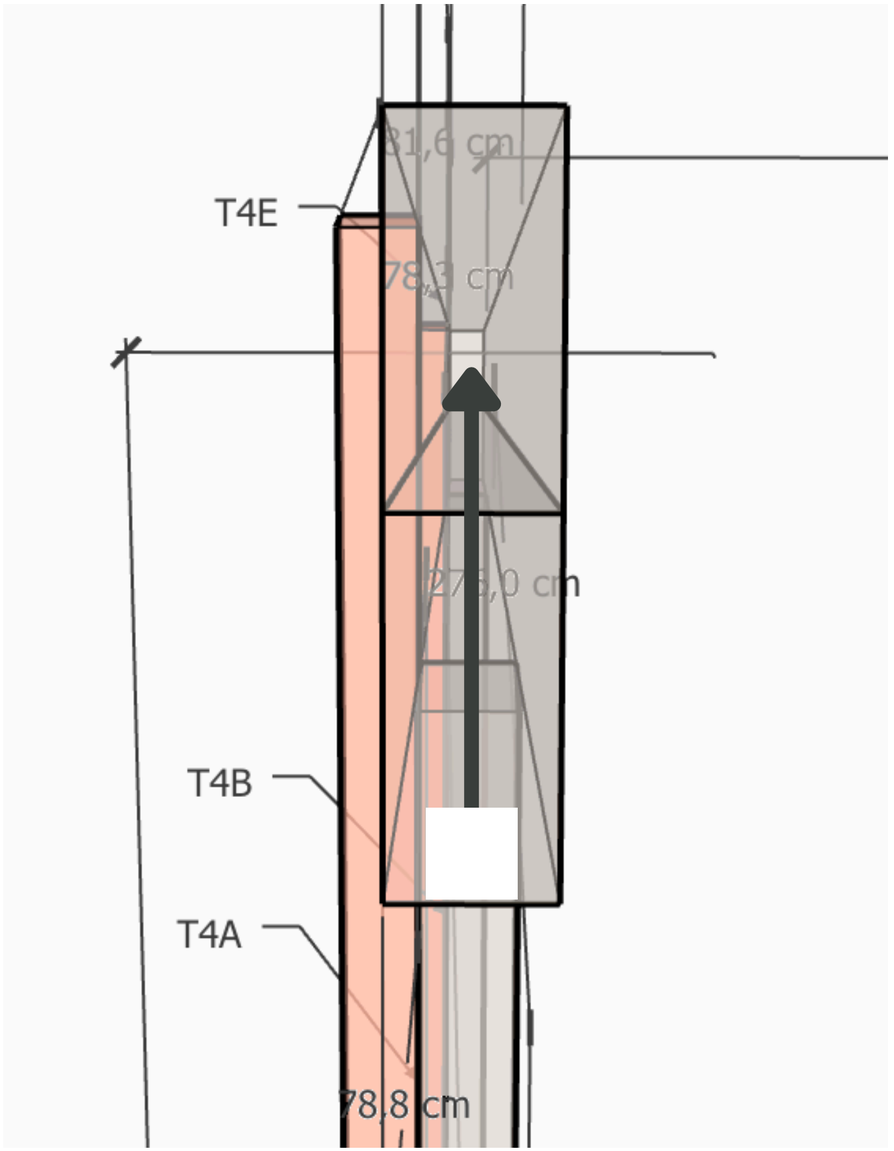
PORTICO TEAM

2 Glue them together, clamp and check that it's aligned

3 Mark and make the pre-holes (+ dig 4cm wider hole than the screw inside the beam)

4 Screw the beams together (screw 6x160) every 50cm

→ The white hole in the drawing represent a 4cm deep hole in the beam so that the screw can be 8cm deep in each beams and not 12cm in the first and 4cm in the second one.

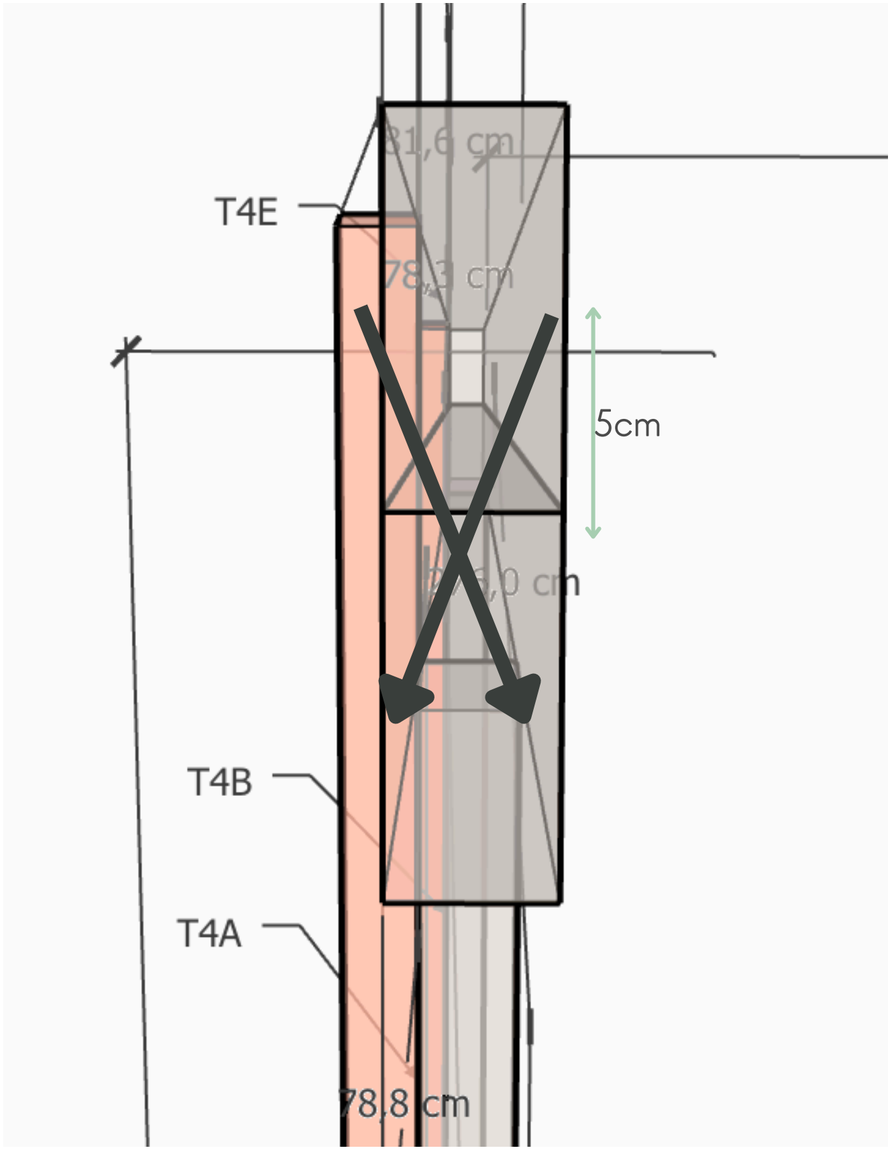


PORTICO TEAM

5 Mark and make de pre-holes in diagonal (5cm from the beam)

6 Screw in diagonal (one every 50cm) (screw of 5x120)

→ TIP FOR SCREWING IN DIAGONAL :
Start screwing vertical few mm and then put the screw in the angle that you want to get.

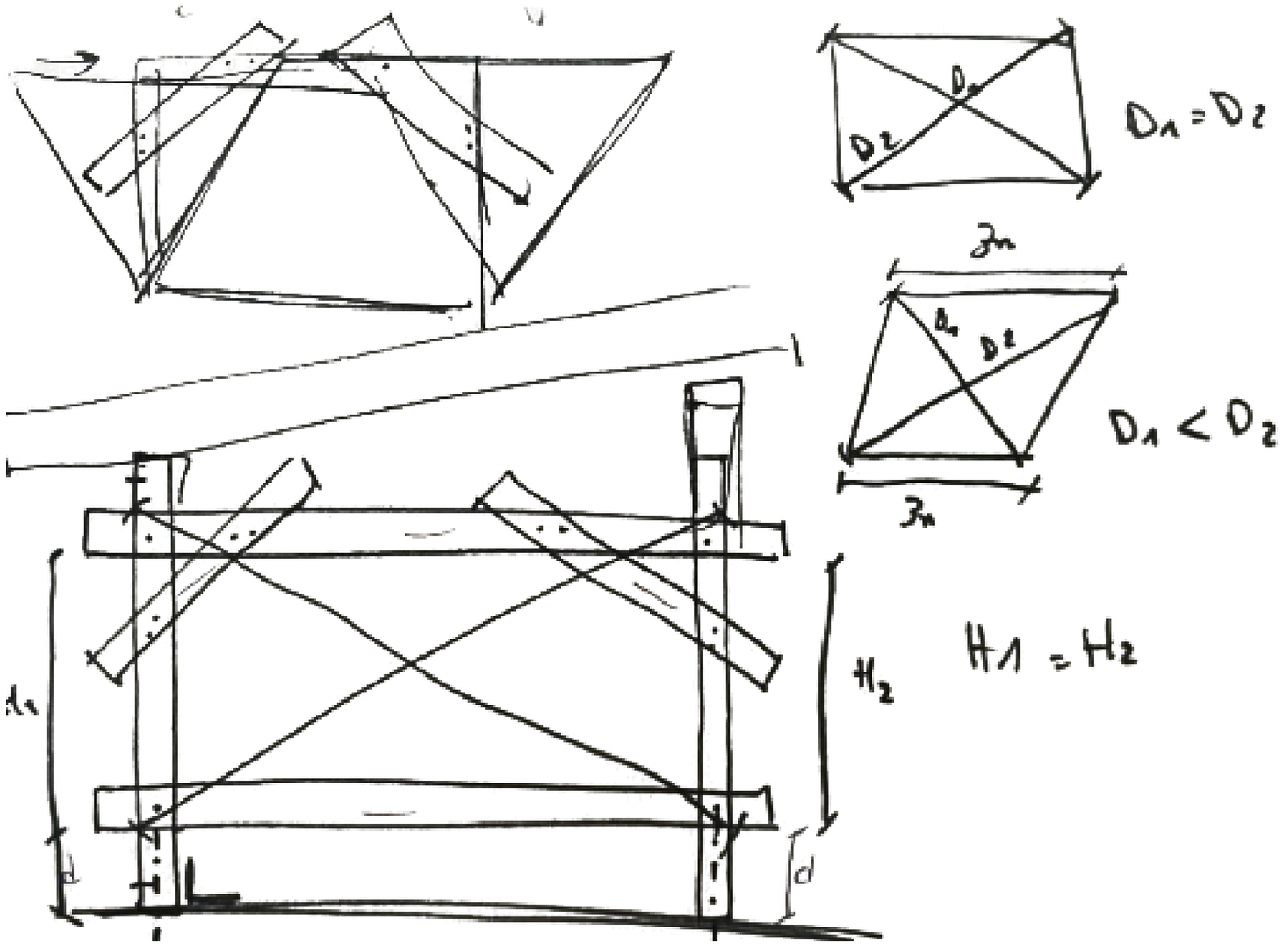


PORTICO TEAM

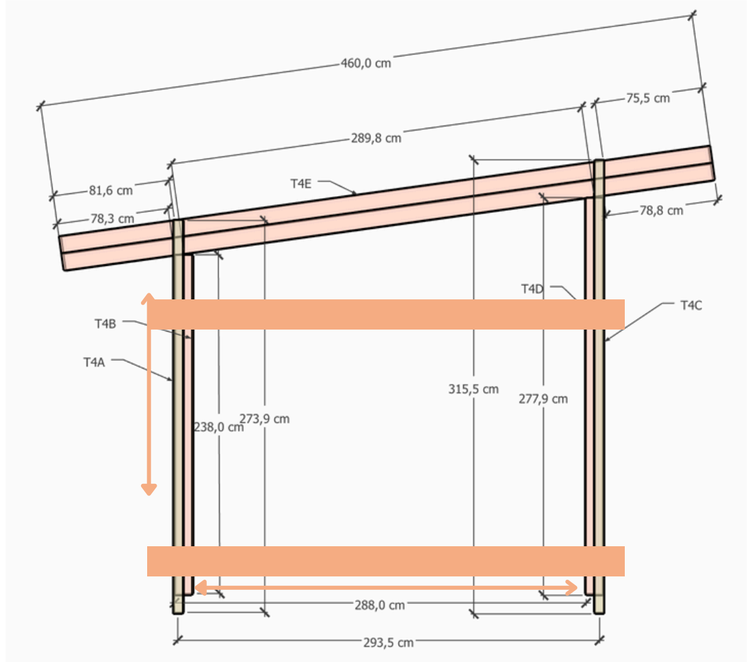
Once you have the pillars and the beam. In order to be sure to keep them in the right distance with the right angle **you need to make a temporary frame.**

<u>You need :</u>

- 2 planks of at least 3m
- 2 planks around 1m but wide enough to get 2 screws



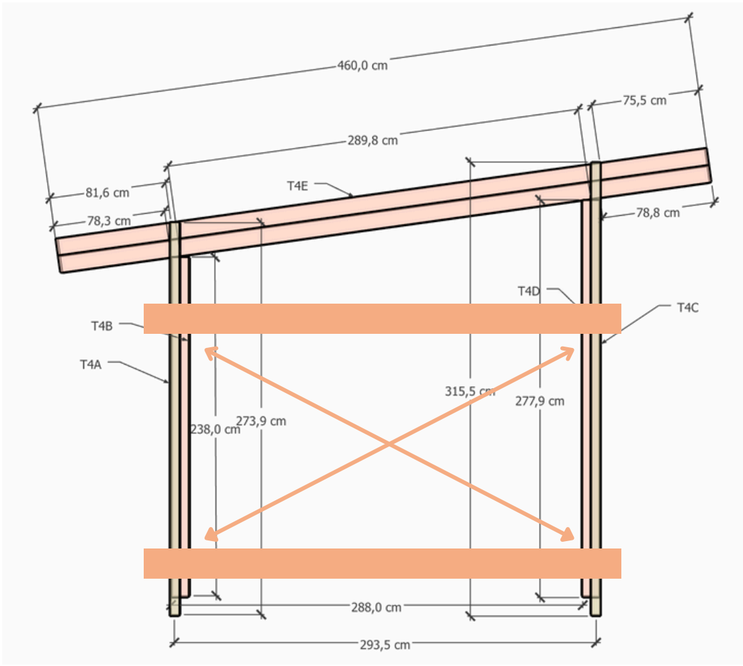
PORTICO TEAM



INSTRUCTIONS :

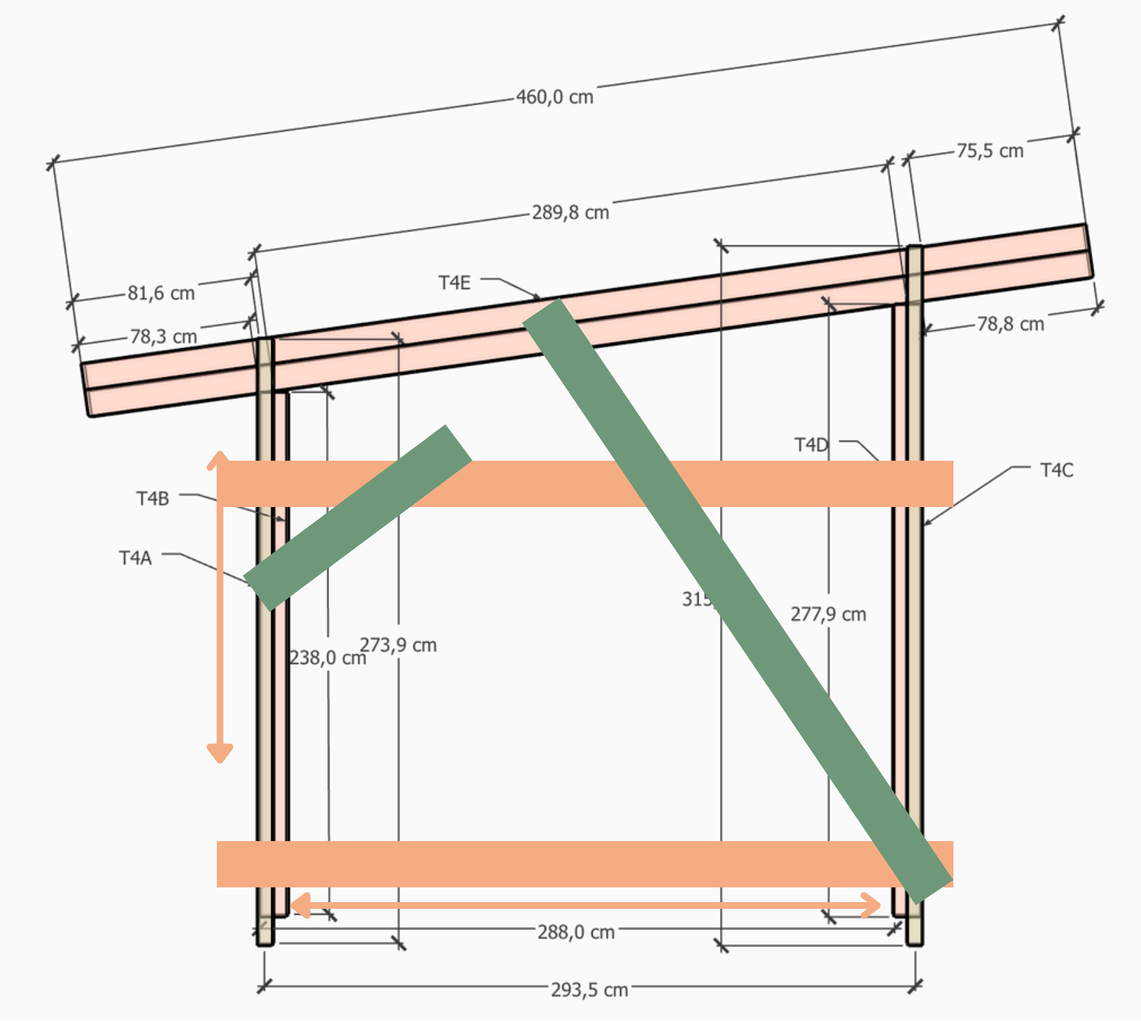
- Start by putting the 2 pillars at the right distance (3m from the outside to the outside of the pillars.
- Fix the plank at the same distance from the bottom of each pillars (d on the drawing)
- Choose a distance for the second plank which should be the same on both sides (h1=h2)
- Make sure there are 3m between the pillars and screw the plank. You should get a rectangle of 3xH1/H2

- Measure the diagonals and make sure they are the same. If not move the frame in order to do so.



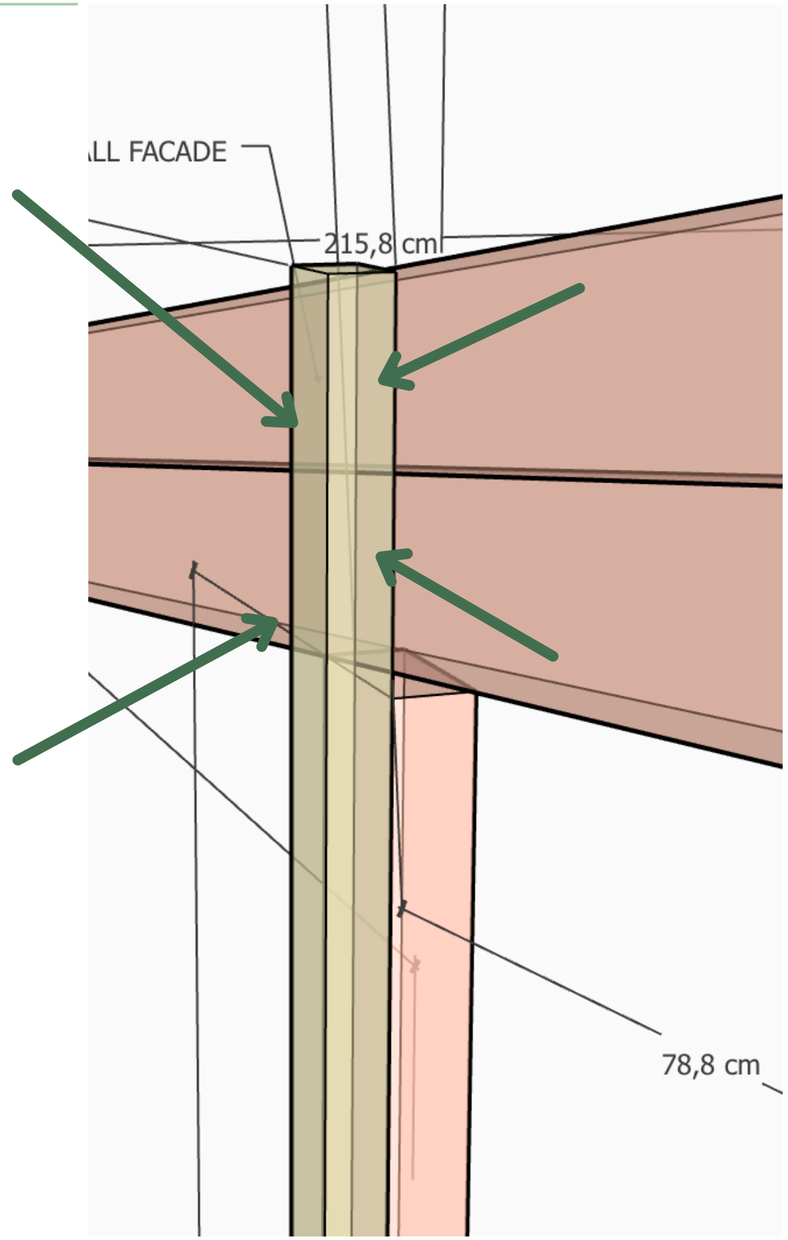
PORTICO TEAM

- Once done, screw temporary planks in diagonal with 4 screws each to make sure the frame won't move.





PORTICO TEAM



1. To assemble the portico : make sure you have a flat surface to work : 4:4meters (! not on the way of the T1 for the wheelbarrow)

2. Assemble the structure together (pre-hole + screws 6x120 in diagonal)

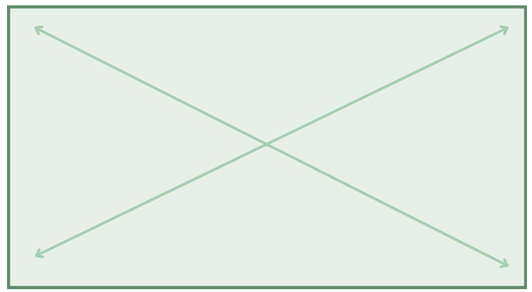
You don’t need to mesure the angle of the beam. Once the pillars are fixed and parallels the angle comes by itself.

T5.
WALL TEAM



WALL TEAM

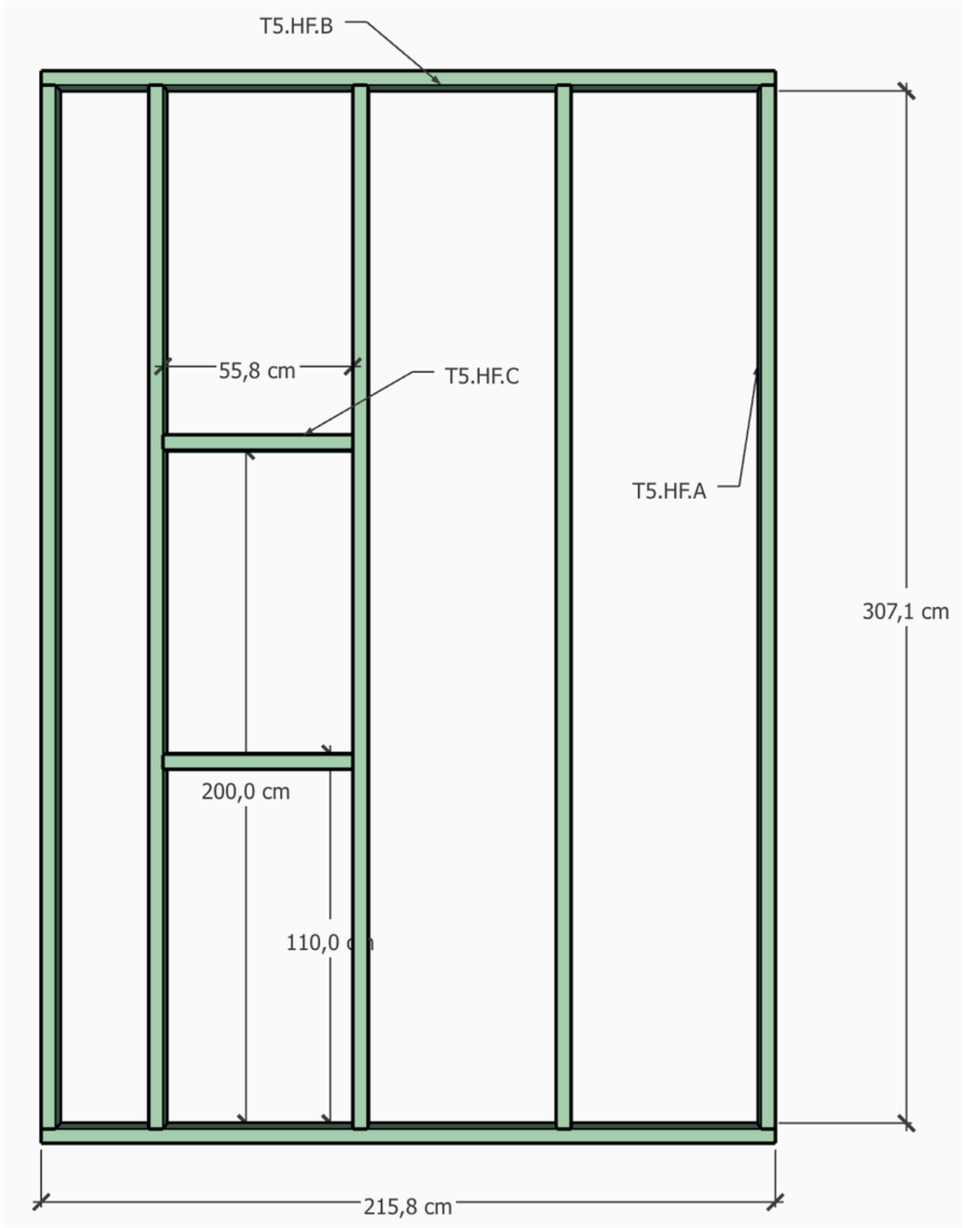
1. Make sure you have a flat surface to work : 4:4meters (! not on the way of the T1 for the wheelbarrow).
2. Assemble the 3 different walls on the ground (screws of 6x120).
3. Make sure they are squared.



4. Fix a plan in diagonal
5. Fix the bamboo ?



WALL TEAM

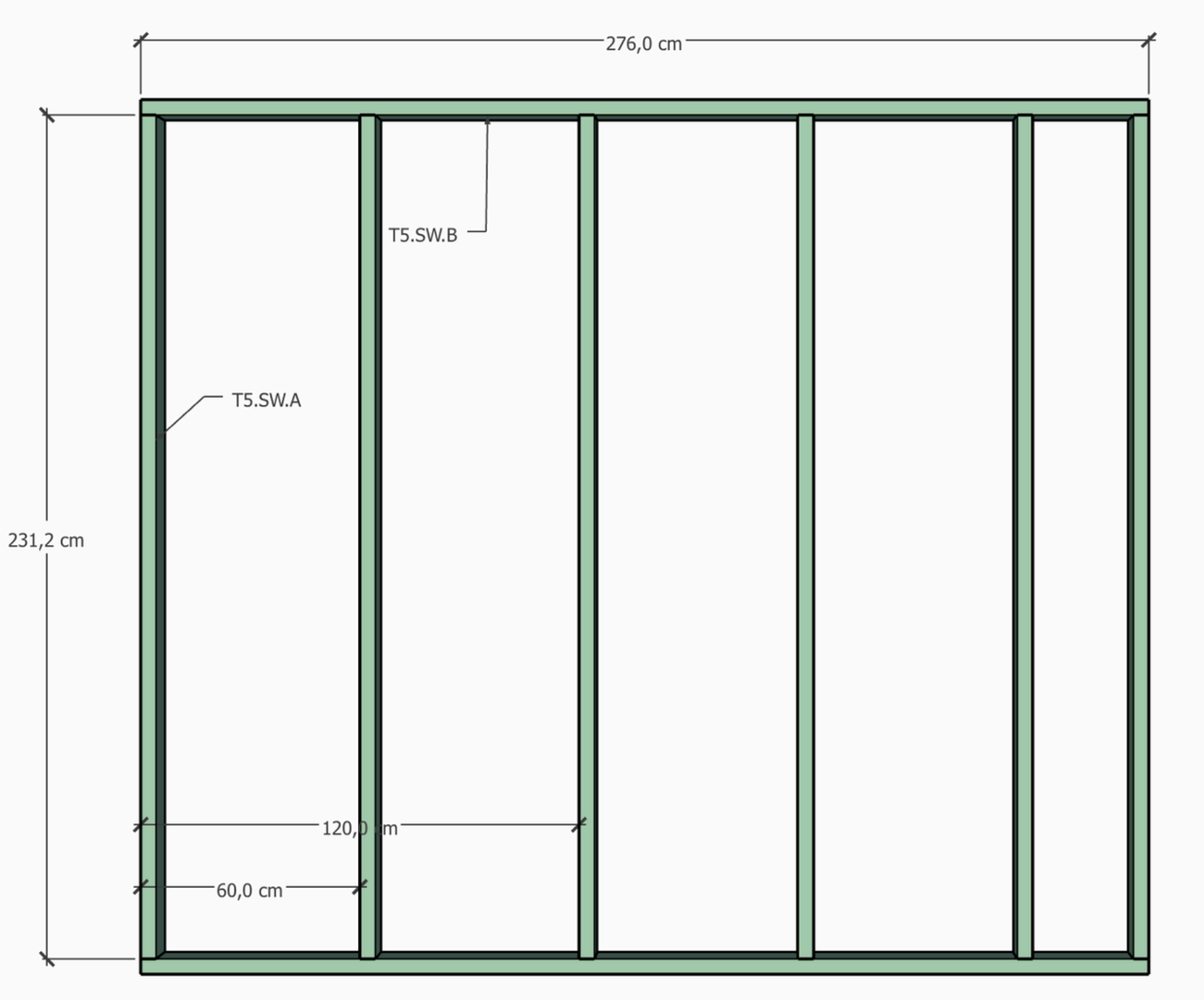


WALL TEAM

3 units



WALL TEAM

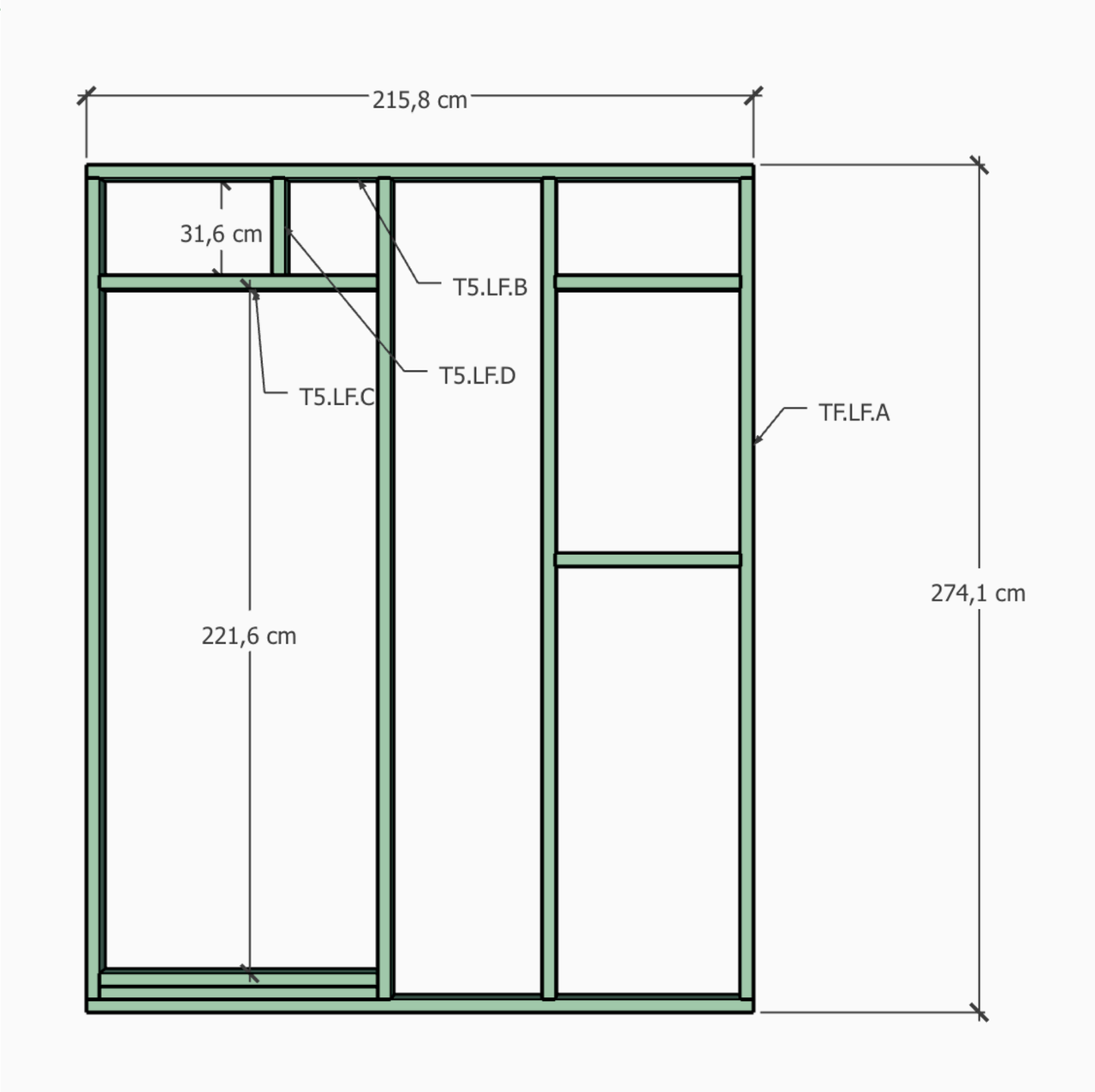


SIDE WALL

2 units



WALL TEAM



LOW FACADE

3 units



WALL TEAM

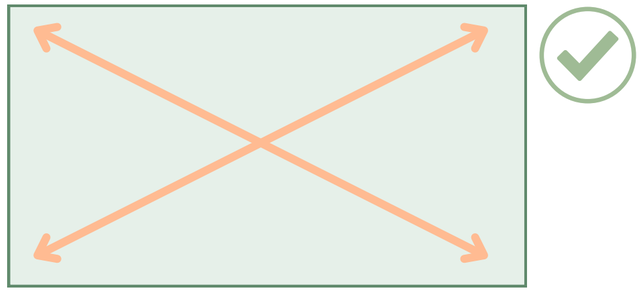
Why diagonal elements matter in wooden structures
In a wooden frame, **diagonal pieces are essential** to keep the structure strong and stable.

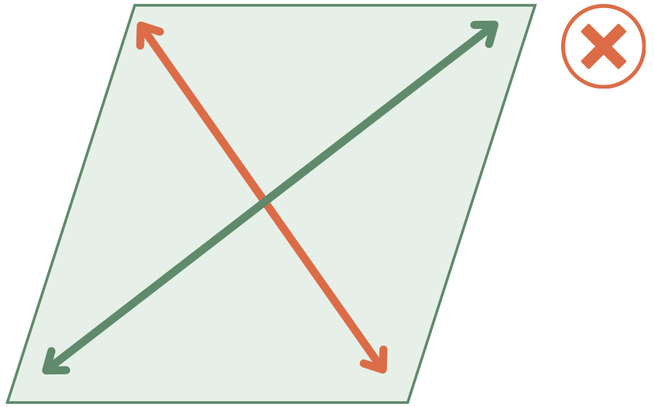
They prevent the walls or frames from moving sideways or collapsing under pressure : this is called bracing.

By forming triangles with the vertical and horizontal parts, diagonals lock the shape and stop the structure from twisting or leaning.

In short: diagonals = stability + strength.

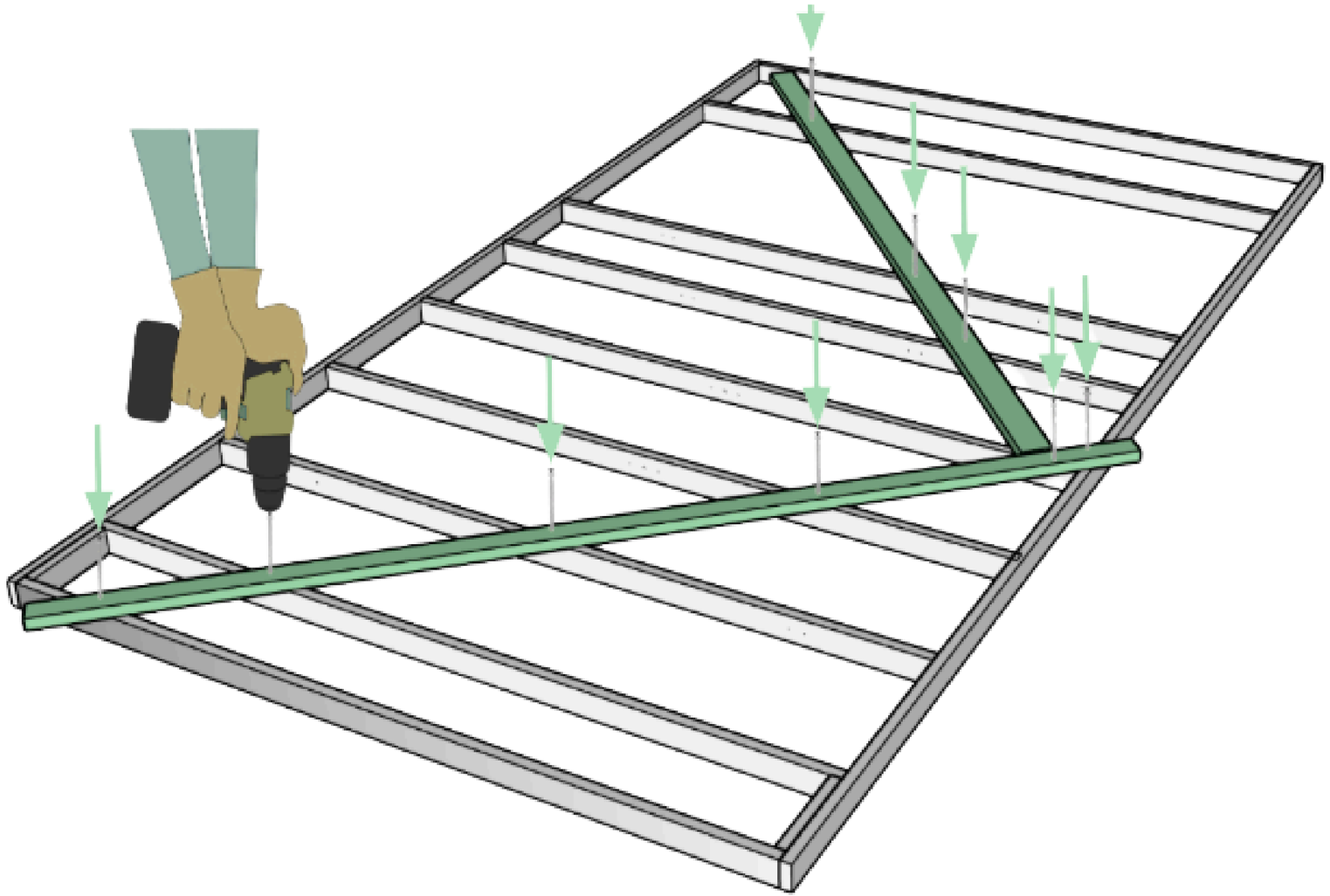






WALL TEAM

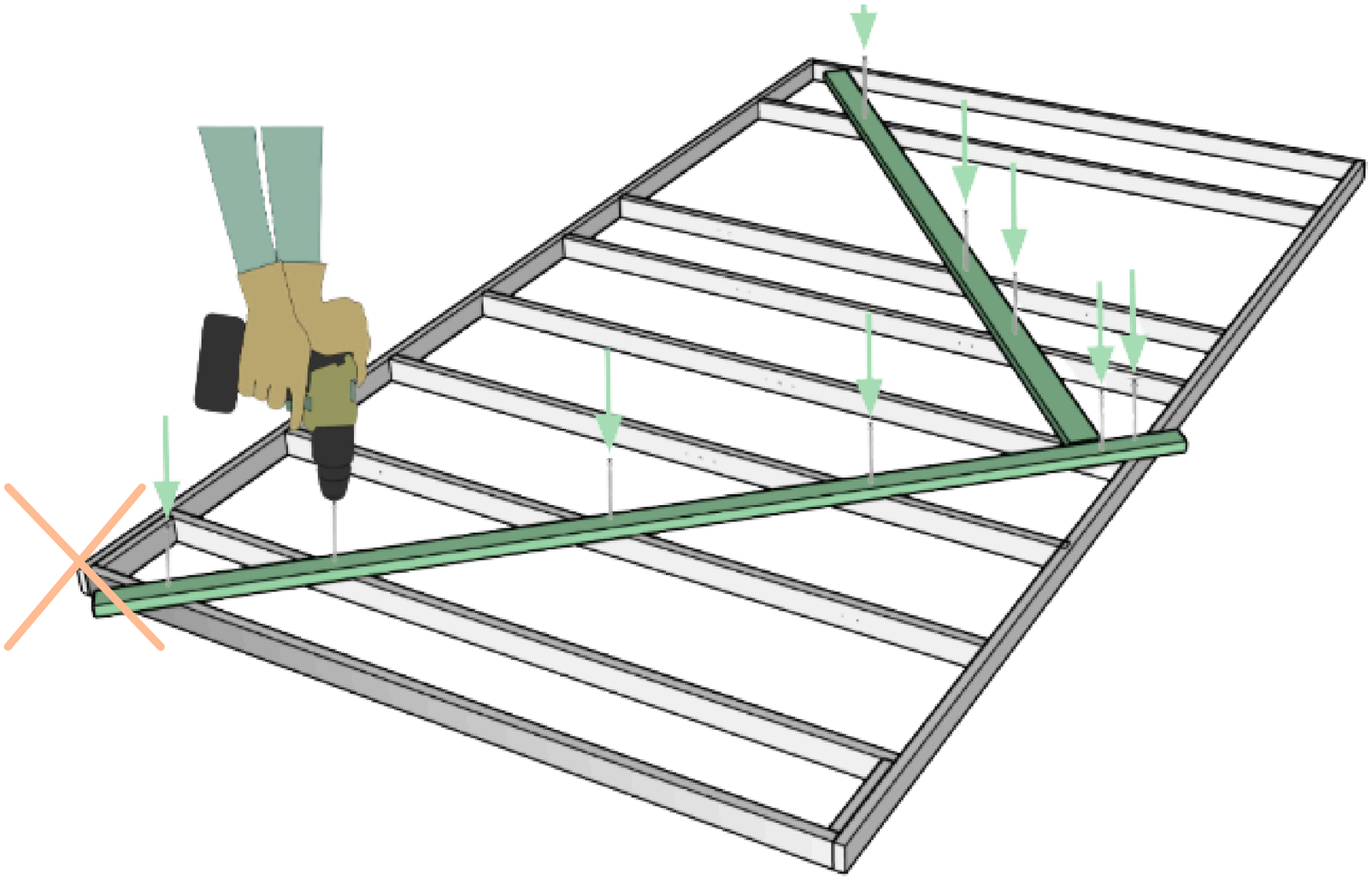
Fix the red elements only when you are sure the 2 diagonals have the same lenght



WALL TEAM

Avoid making the diagonal braces longer than the wall.

This will prevent them from getting in the way during assembly, for example if they touch or block another wall.

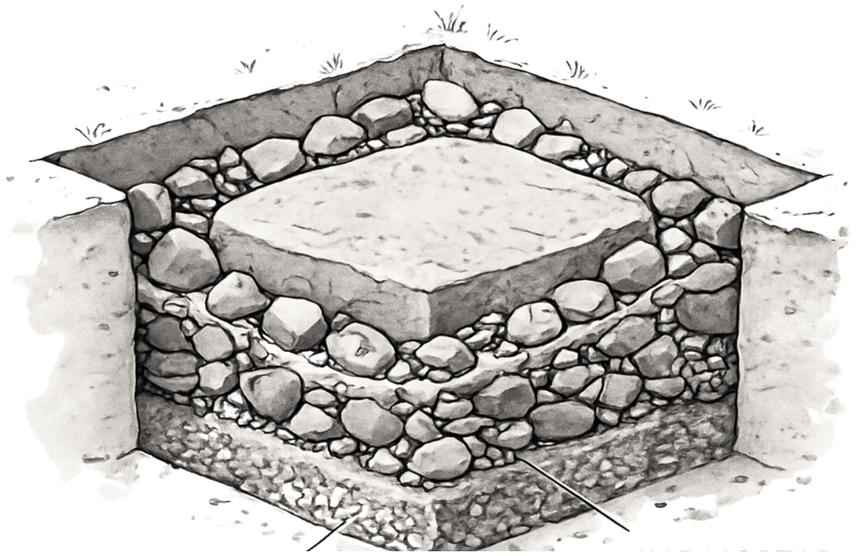


T6.
ASSEMBLING THE FLOOR ON THE FOUNDATION

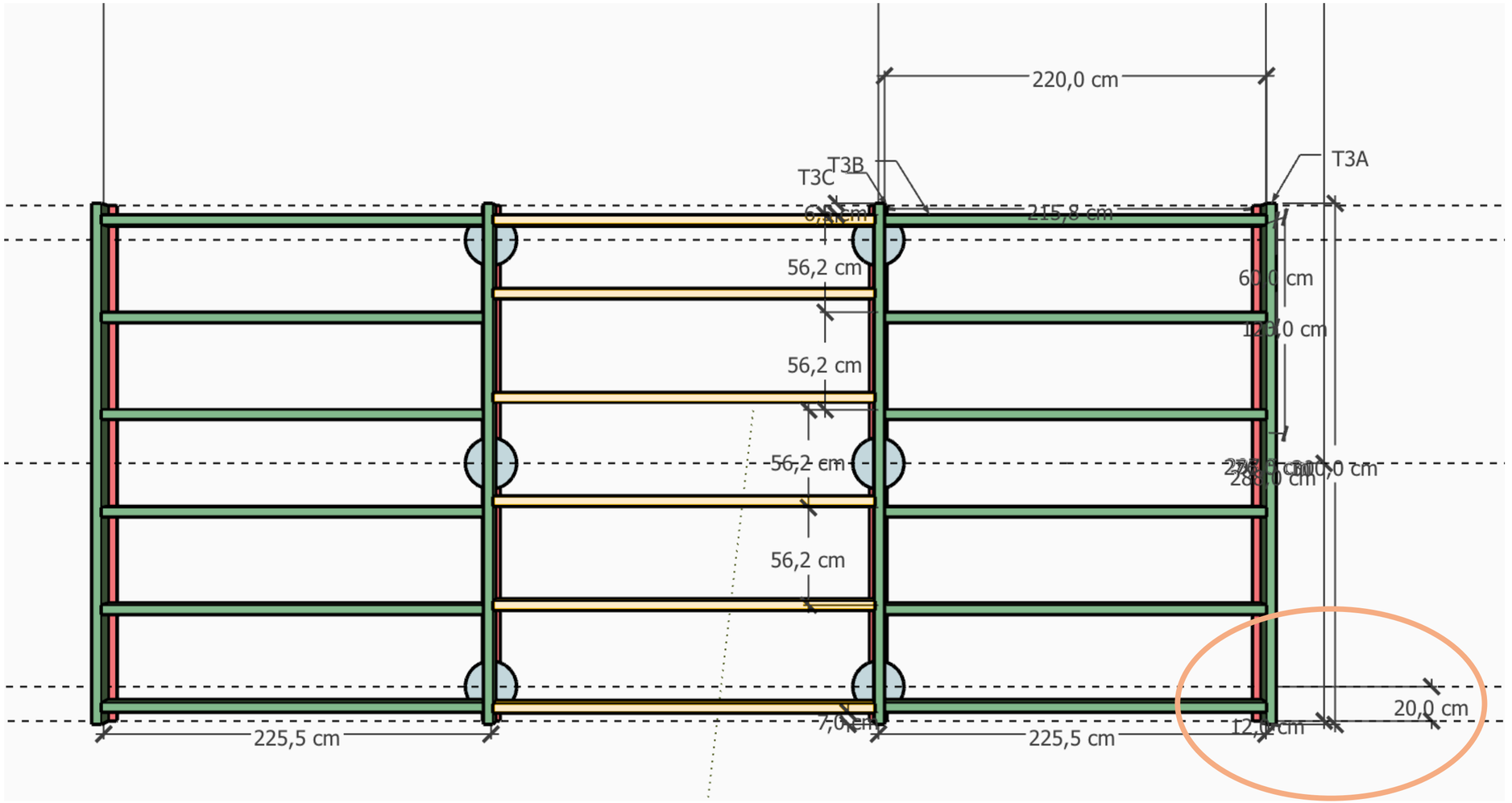


ASSEMBLING TEAM

1. Cut the threaded rods : 12 pieces of 33cm (cut the rod in 3).
    a. check if the bolts can still pass threw the rods.
    b. put on nut on the rod (in the beginning of the rod, on the side that will be placed “up”)
2. Bring the floor on site
3. Place it on the exact place : check the level, the reference line and the stone
4. Make sure the floor stays in place (hold it carefully while people is making the holes)
5. Make the hole in the wood structure (diameter 25mm) ! don’t touch the stone with the drill
6. Make the hole in the stone (diameter 25mm)
    a. tools : power driller, wear protection, …
7. Move the wooden structure
8. Clean the hole in the stone :
    a. tools : compressor or bicycle pump
9. Put the chemical glue in the hole. 2 fingers before the end
10. Put the rod inside the hole, turning it clockwise so that the glue can be spread everywhere on the rod
11. Wait 22 minutes to dry
12. Put the floor confirming the position
13. Level the nuts to make the floor at the good level



ASSEMBLING TEAM



The axis of the foundation is at +/-
20cm inside from the floor

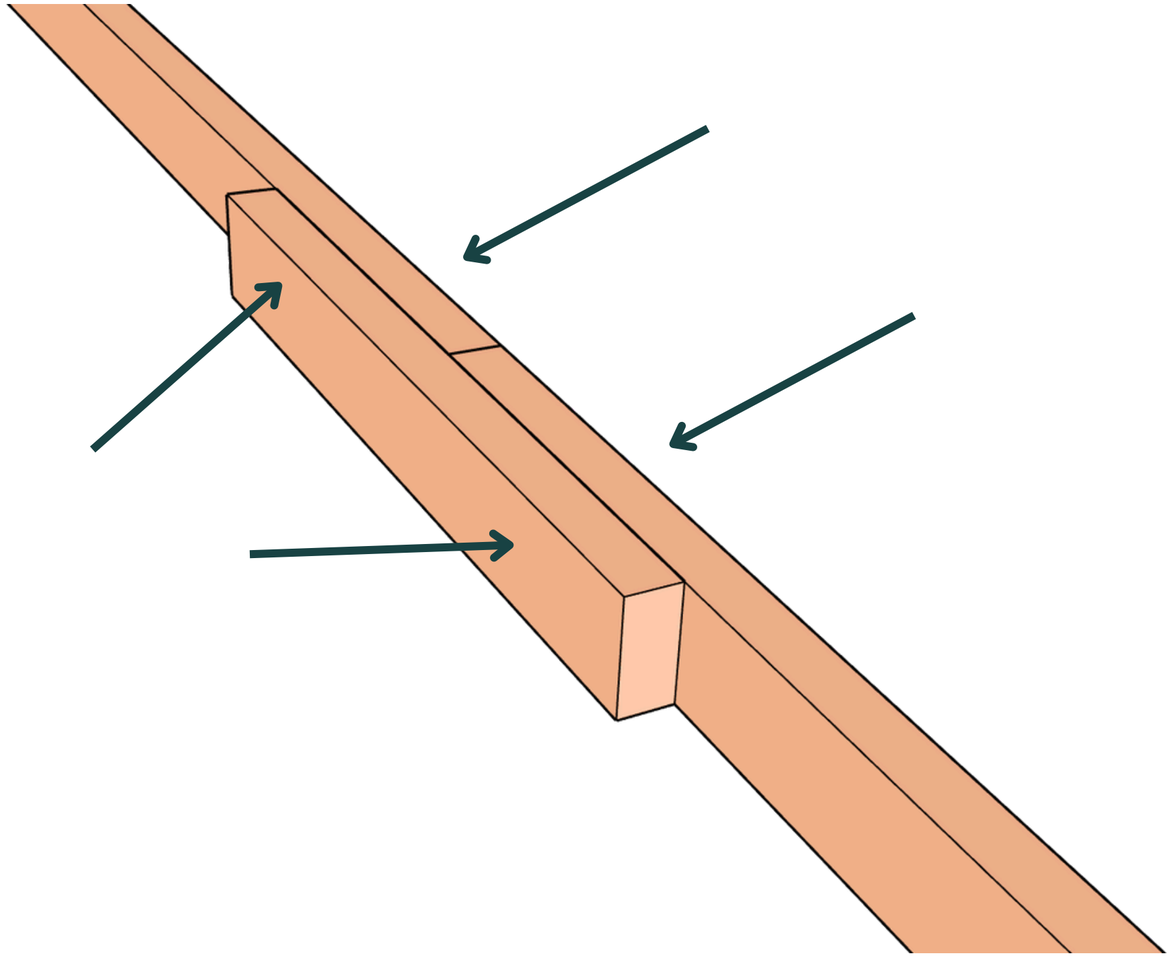
T7.
BEAMS ROOF TEAM



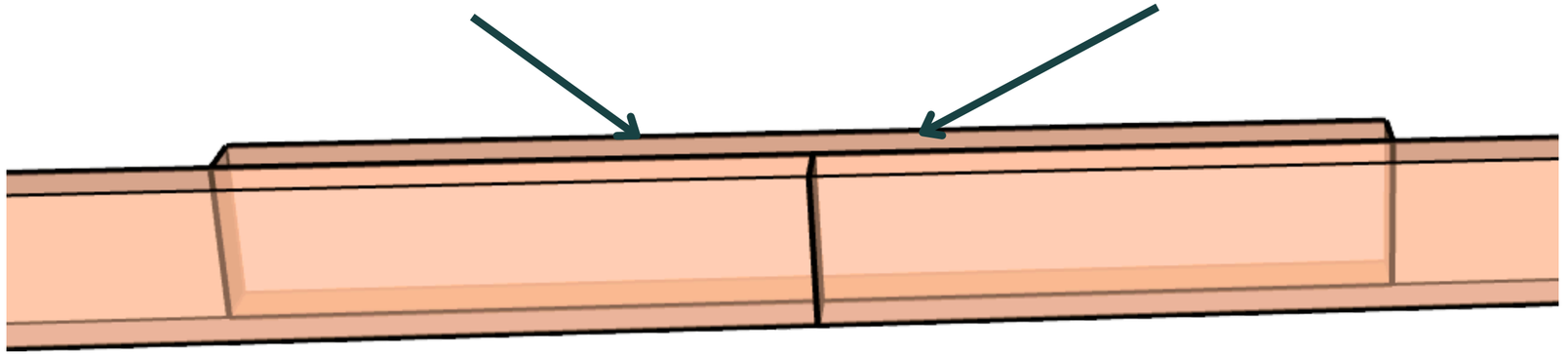
BEAMS ROOF TEAM

1. Cut the beams (cutting team)

2. Assemble the beams with the leftovers (minimum 60cm lenght, and it should be a section of 55/120)
    a. Check it is straight
    b. Glue and clamp
    c. Screw of the cuttings to screw it aside (from each side, 6/120 in diagonals)



BEAMS ROOF TEAM



3 To reinforce the assembly : screws of 6/160 in diagonal to reinforce the joinery

FLOATING TASK :
- make 2 pre-hole in the 30cm pieces of the roof

T8.

CLAY PLASTER TEST

FIRST LAYER



CLAY PLASTER TEST

Prepare **several test frames** on a wall (Ilektra's office ?) (about 20 × 20 cm, 3 cm thick) to compare different mixes.

All proportions below are given in volumes:

1. Clay 1 / Straw 0 / Sand 0
2. Clay 1 / Straw 1 / Sand 0
3. Clay 1 / Straw 1 / Sand 0.5
4. Clay 1 / Straw 1 / Sand 1
5. Clay 1 / Straw 1 / Sand 1.5
6. Clay 1 / Straw 1 / Sand 2
7. Clay 1 / Straw 1 / Sand 2.5

Use straw fibers around 10 cm long.

MIXING TIPS
Add water little by little : the mix should stay compact and plastic, not liquid : easily moldable, not crumbly, does not stick to the fingers.







CLAY PLASTER TEST

TO CHECK THE RIGHT MOISTURE:

Make a small ball in your hand with your mix (5-7cm diameter) and drop it from +/-1 meter high : If it stays in one piece (not smashed flat), the water content is good.

T9.

PREPARATION OF THE WALLS

(OUTSIDE WATER PROOF LAYER)





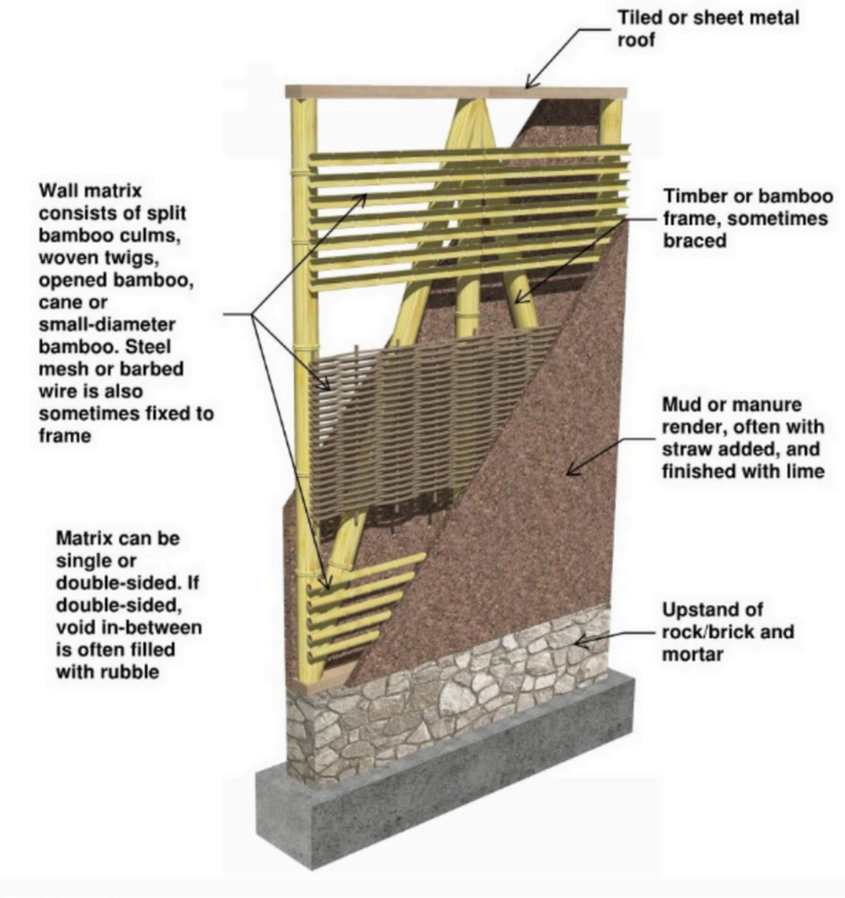
Go picking the bamboos
a. Saws, secators, …

PREPARATION OF THE WALLS

Prepare the bamboo on the walls :

1. Cut the bamboos on the dimensions of the walls
   Fix the bambou with screws of 5x50 or nails of 5cm
2. Be aware to don't place the thinner part os the
3. bamboos always to the same side





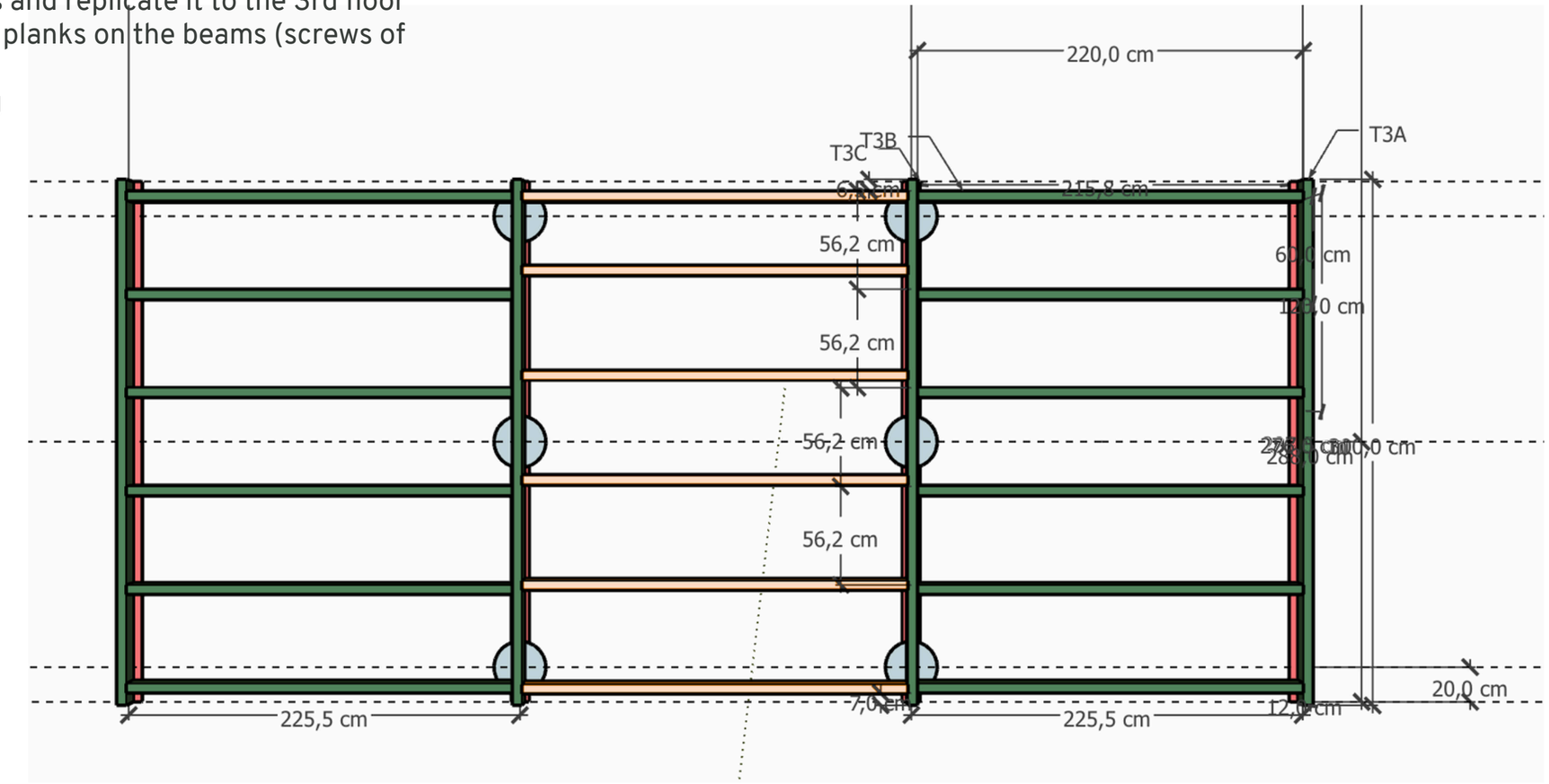
Source : https://eartharchitecture.org/?cat=80

T10.
TEAM
3RD FLOOR



TEAM 3RD FLOOR

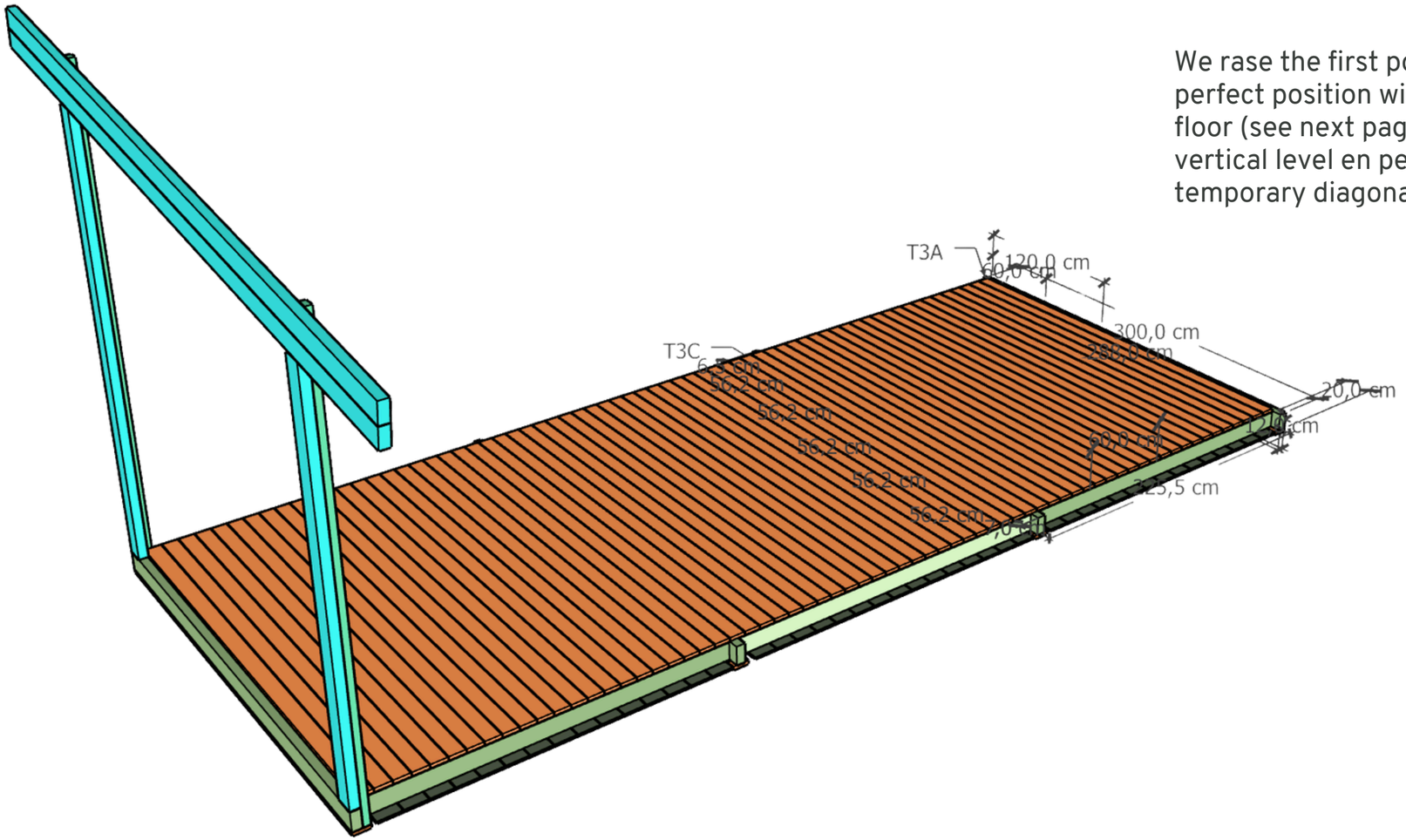
1. Calculate the length of the beams
2. Cut the beams if necessary
3. Assemble them with a temporary structure to make a frame
4. Take the measure of the diagonals between the existing floors and replicate it to the 3rd floor
5. Assemble the planks on the beams (screws of 5x50)
6. Oil everything



T11.
ASSEMBLING OF THE ELEMENTS



ASSEMBLING OF THE ELEMENTS

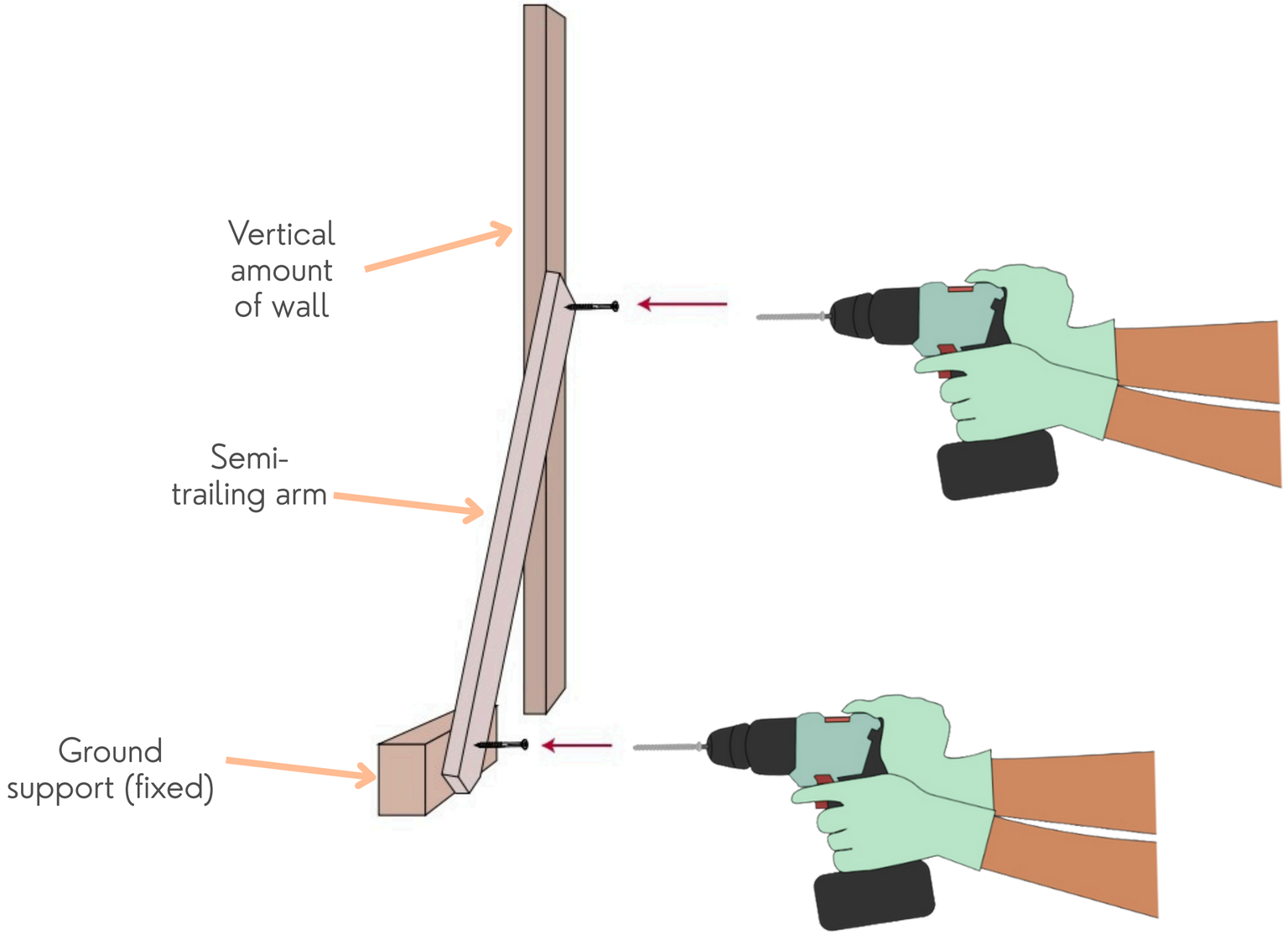


We rase the first portico and we secure it in the perfect position with temporary diagonals to the floor (see next page) - be sure that you have the vertical level en perfect position before screwing temporary diagonals.

ASSEMBLING OF THE ELEMENTS

As soon as the first element is set up on the structure, it's important **to stabilize it quickly**.

To do so, use temporary diagonal braces, fixed at an angle as close as possible to 45° (approximately).

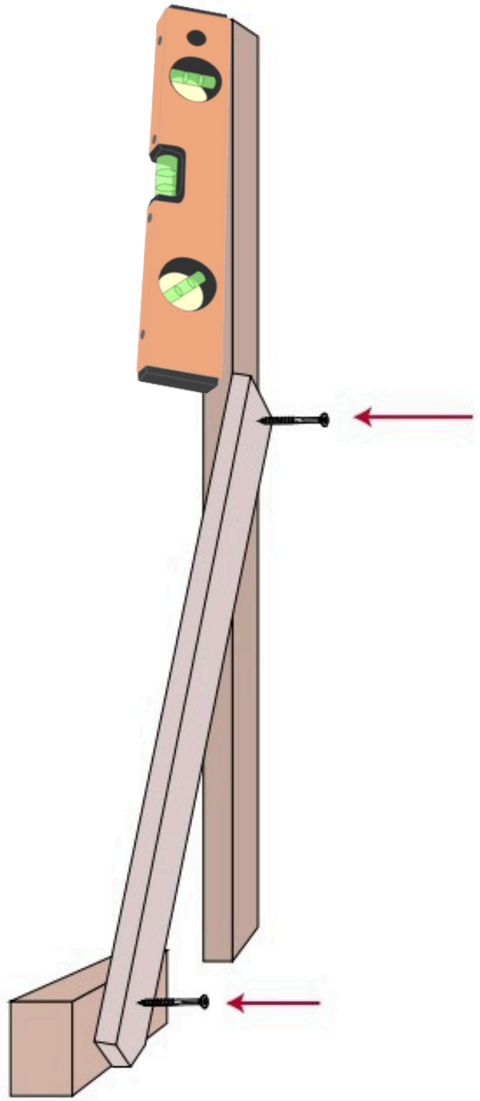




ASSEMBLING OF THE ELEMENTS

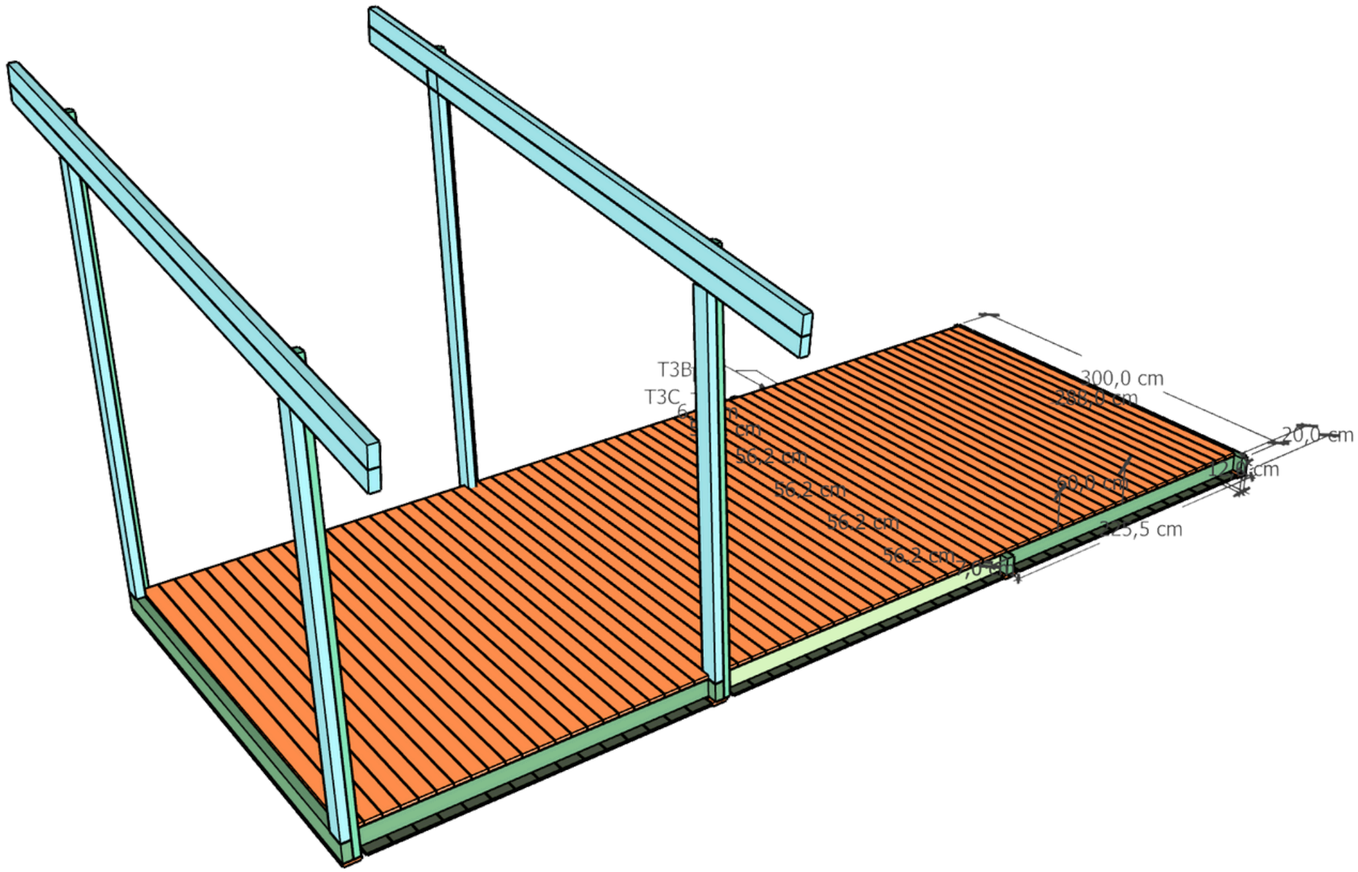
ASSEMBLING OF THE ELEMENTS

Check the vertical alignment of the elements before fixing the diagonal, to ensure the next assembly steps can be carried out accurately.



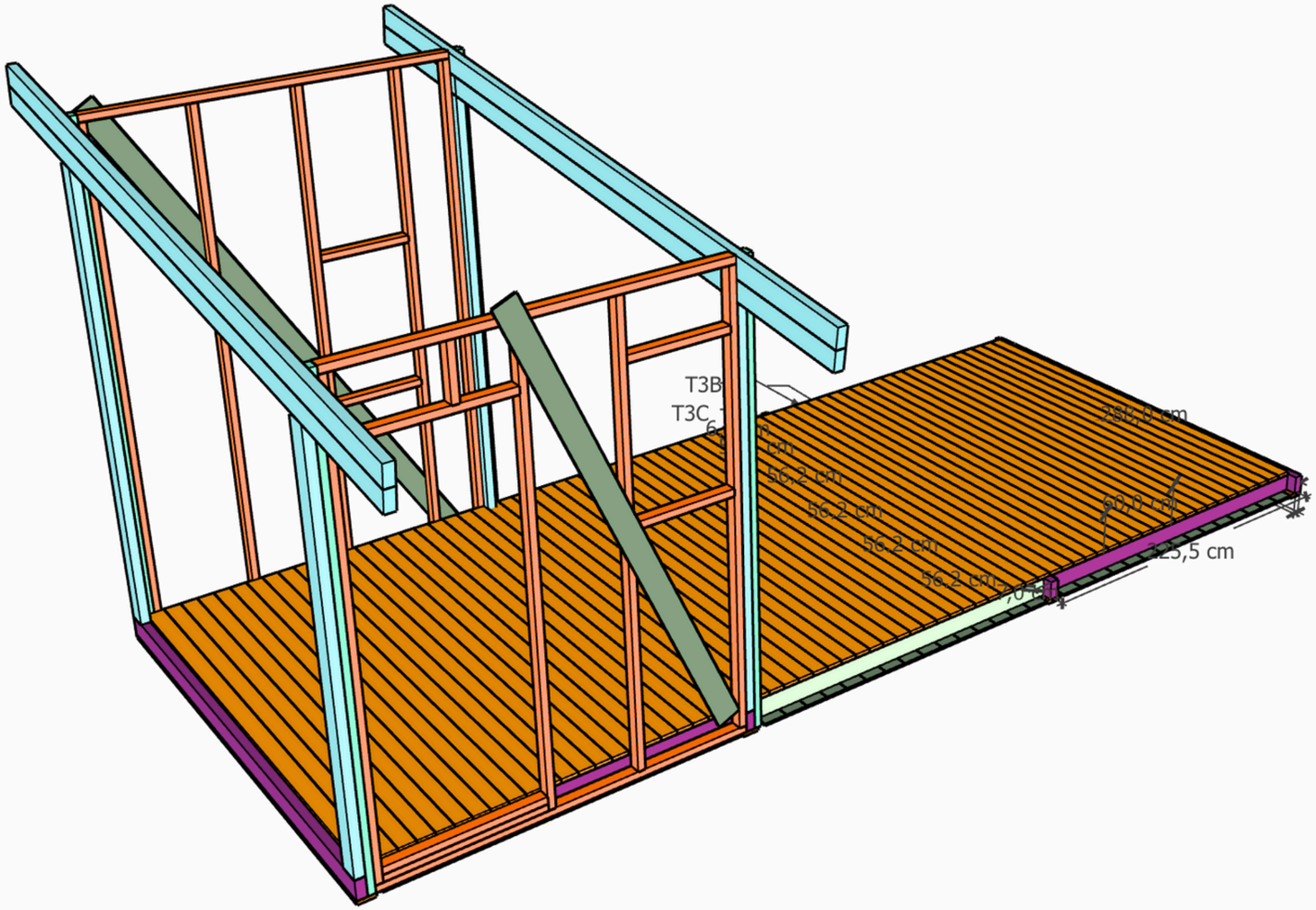
ASSEMBLING OF THE ELEMENTS

Place the second portic and
do the same procedure.



ASSEMBLING OF THE ELEMENTS

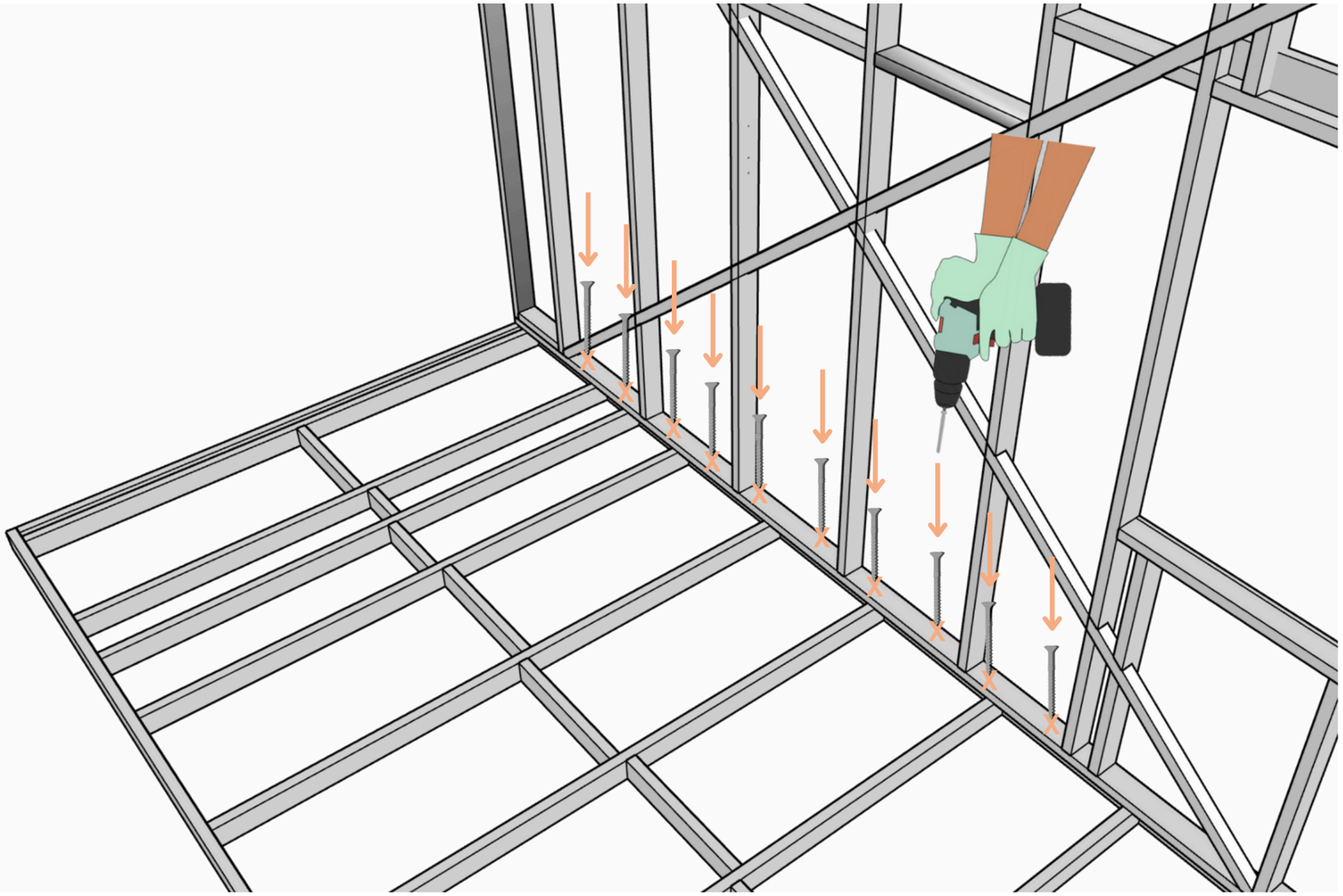
Bring two walls, screw them to the floor and both porticos. After you can remove the temporary diagonals that you used to level the porticos



ASSEMBLING OF THE ELEMENTS

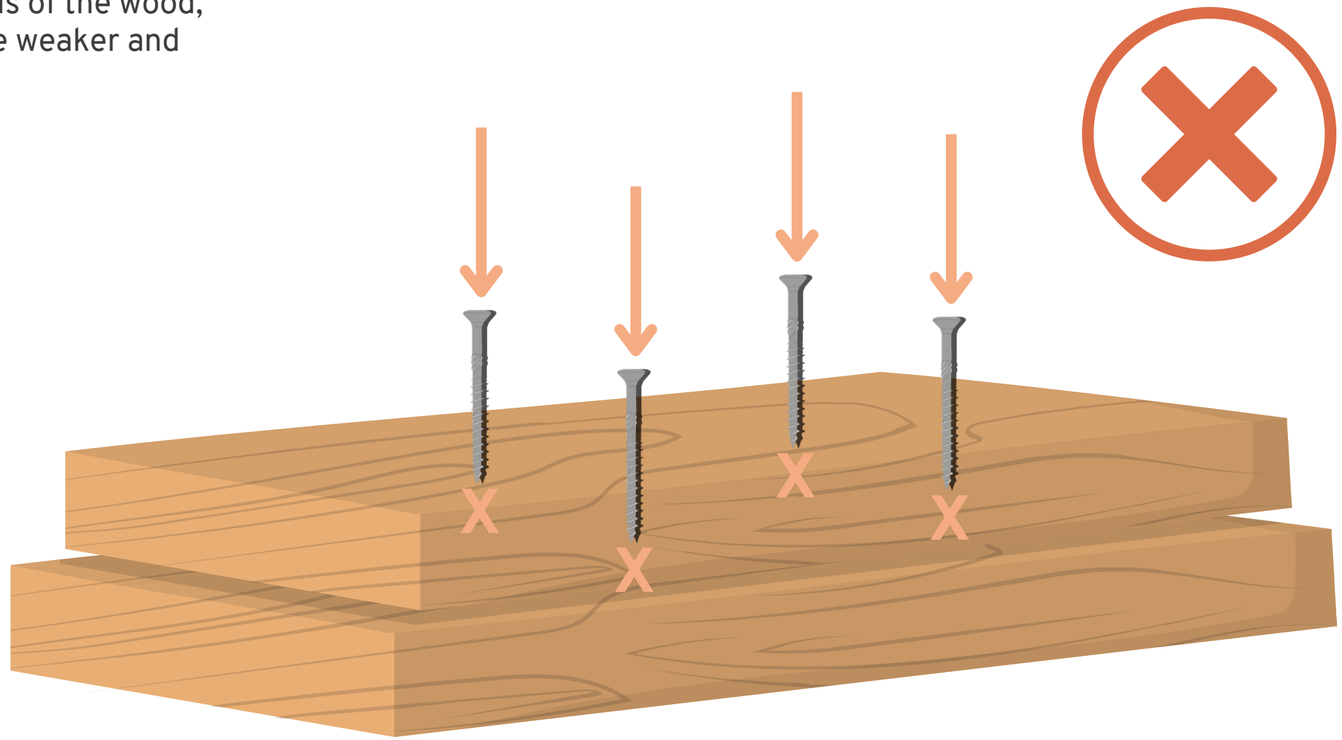
Bring two walls, screw them to the floor and both porticos.

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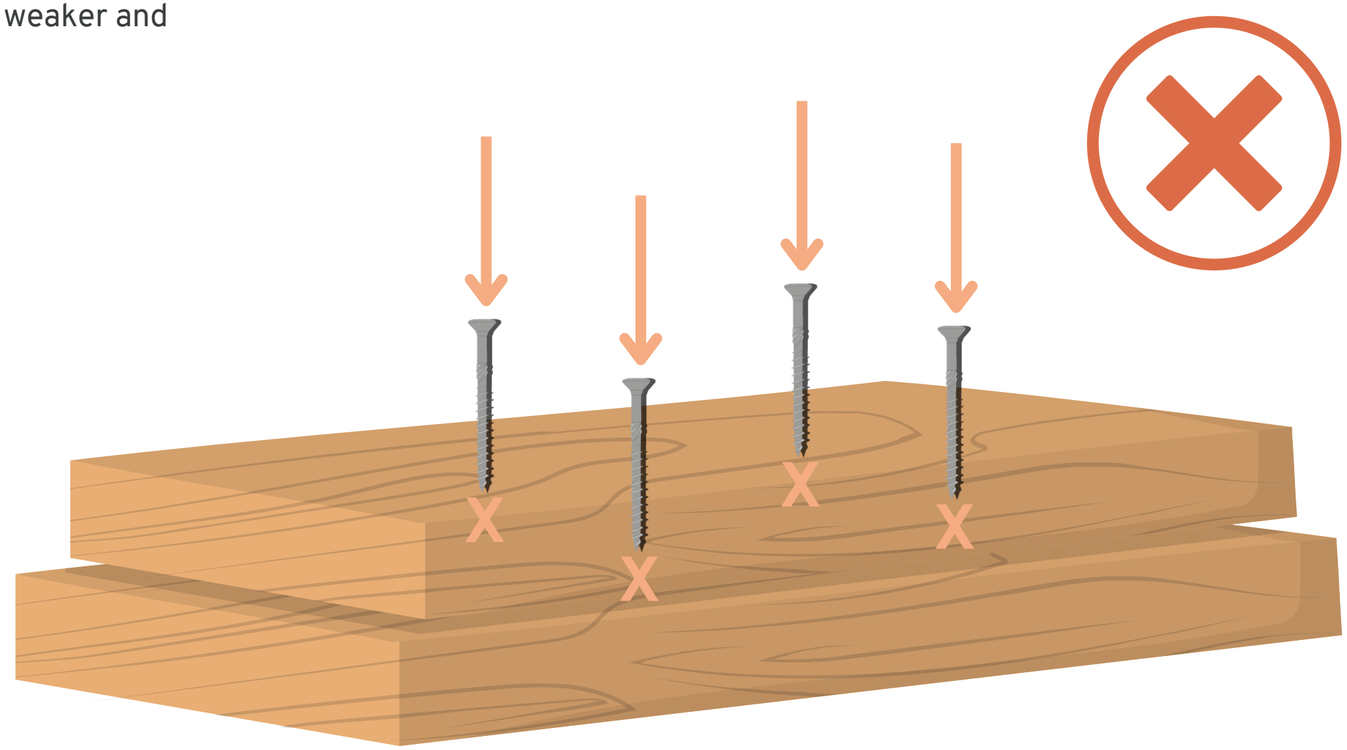
ASSEMBLING OF THE ELEMENTS

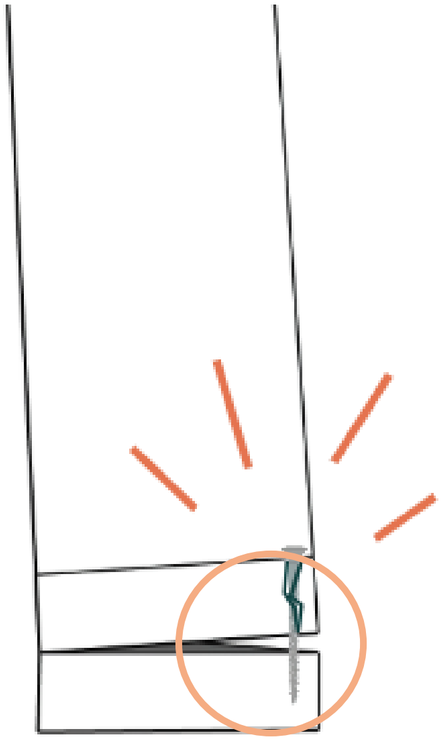
However, avoid placing screws too close to the ends of the wood, where the fibers are weaker and more likely to split.



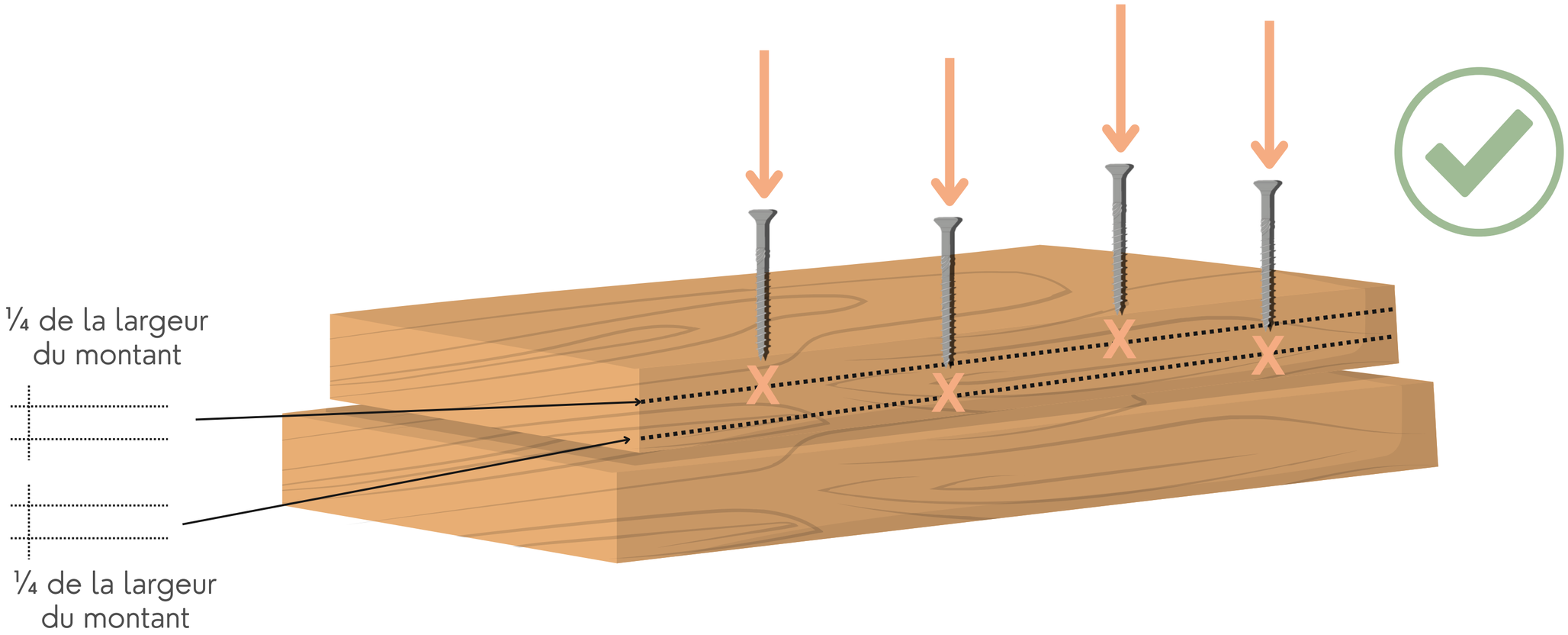
ASSEMBLING OF THE ELEMENTS

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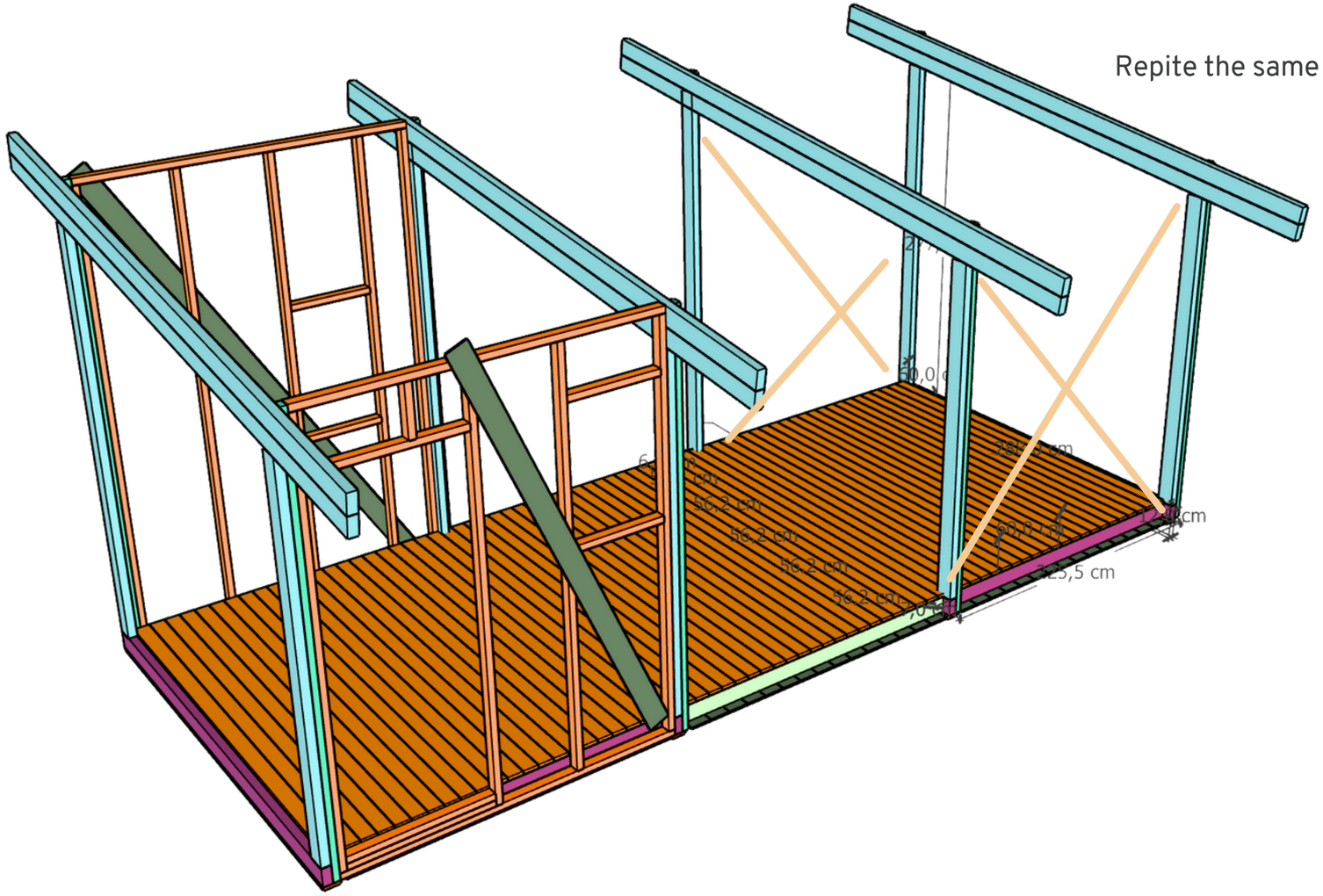




ASSEMBLING OF THE ELEMENTS

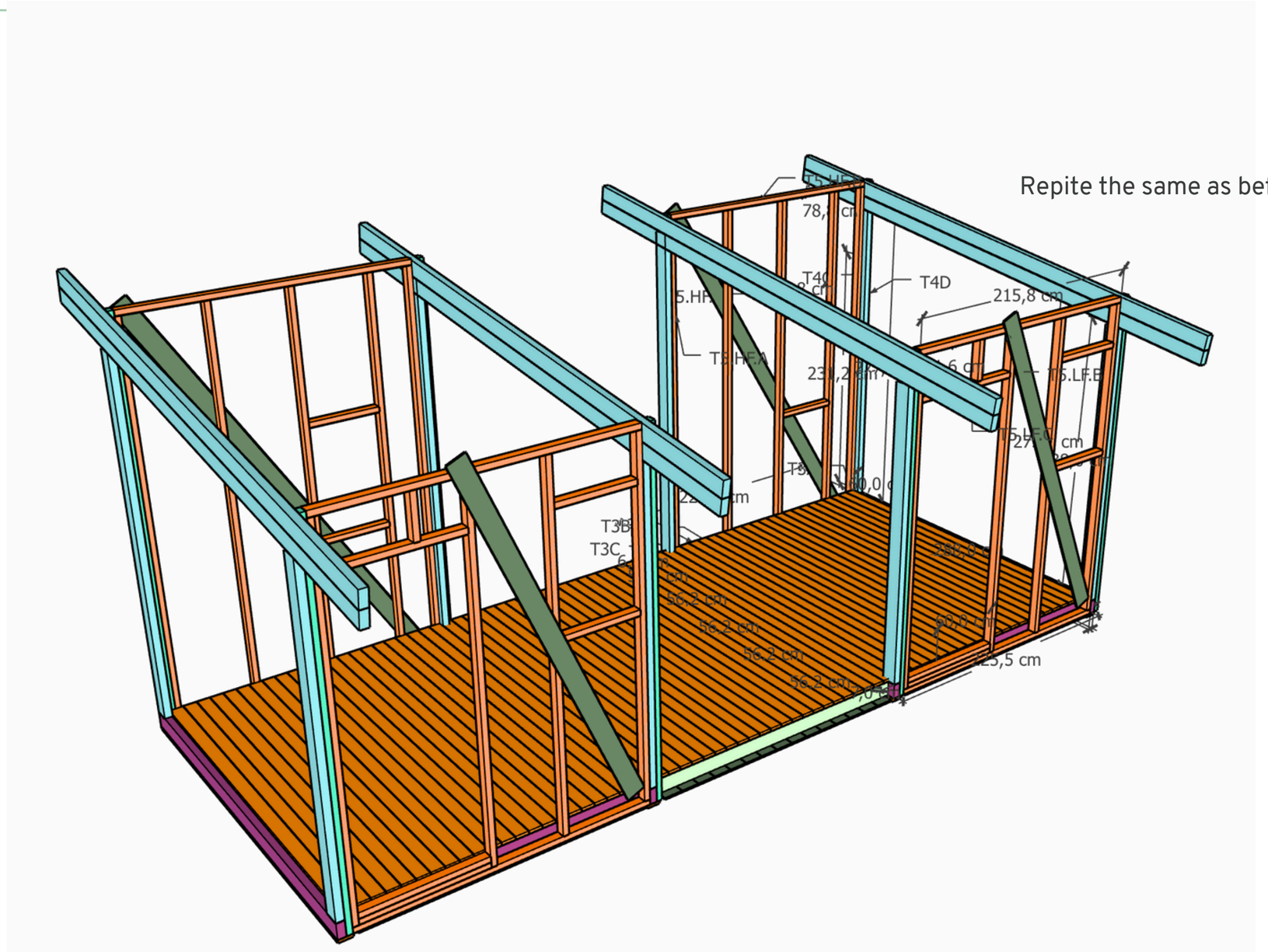


ASSEMBLING OF THE ELEMENTS



Repite the same as before

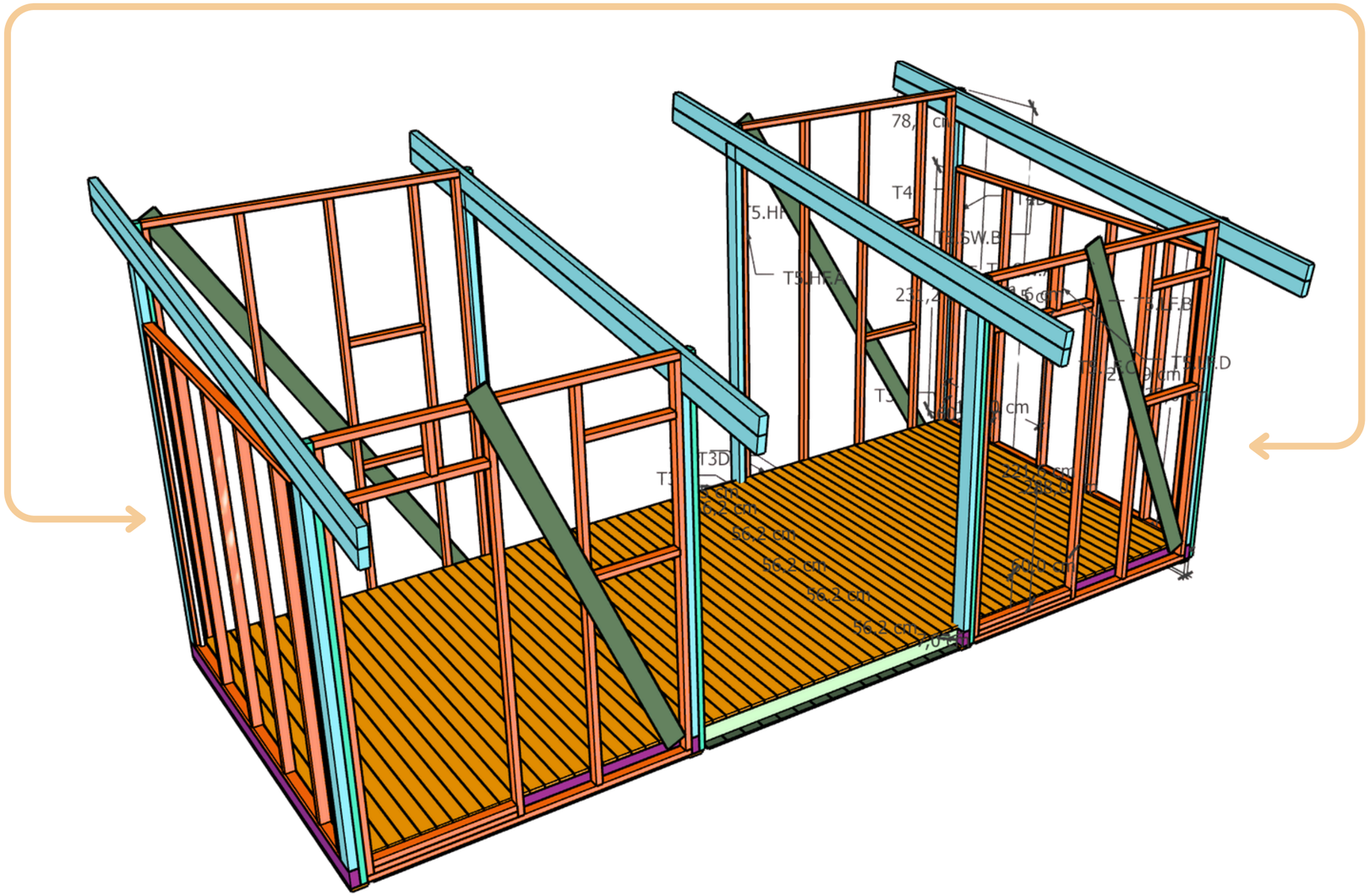
ASSEMBLING OF THE ELEMENTS



Repite the same as before

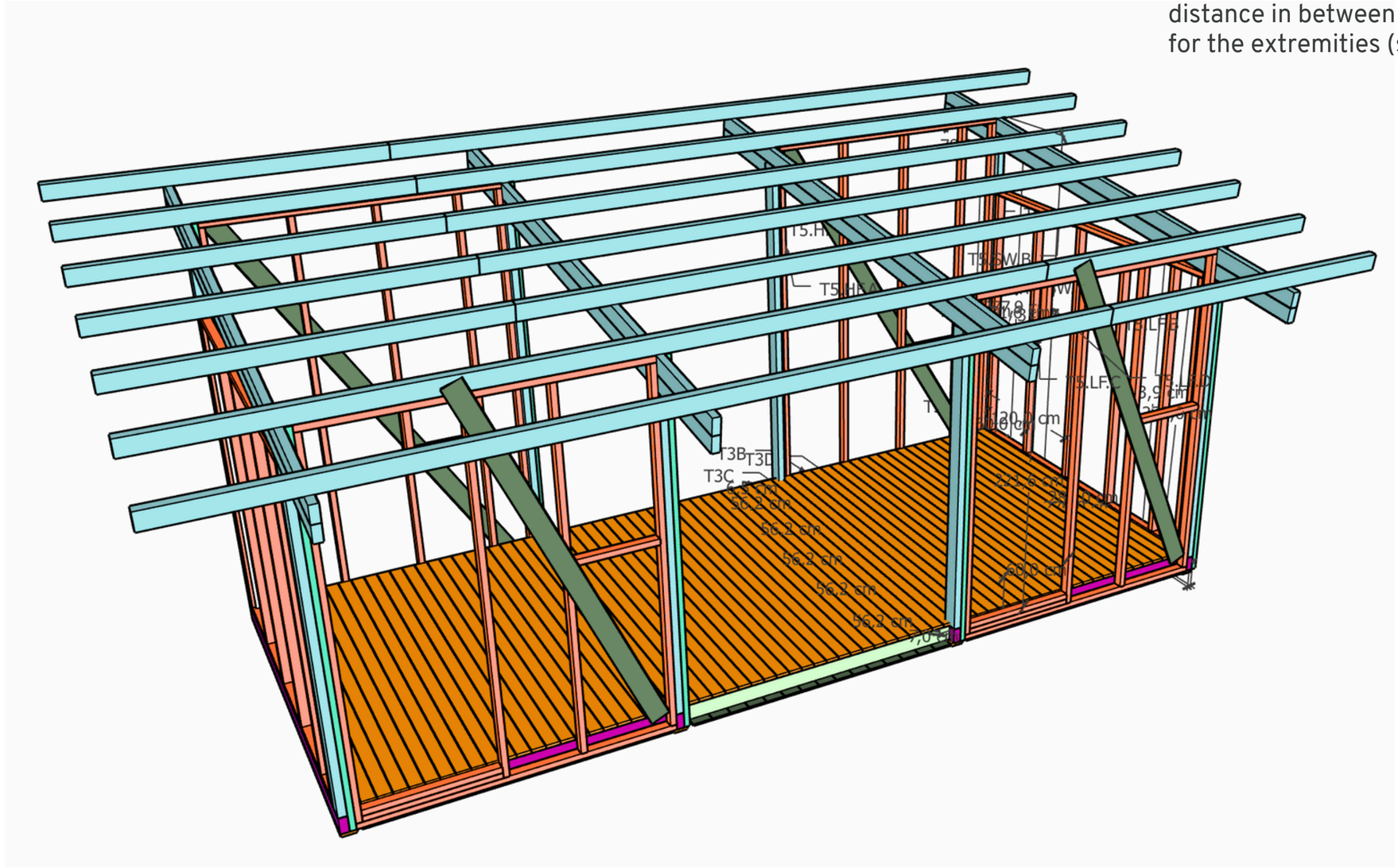
ASSEMBLING OF THE ELEMENTS

Place booth side walls



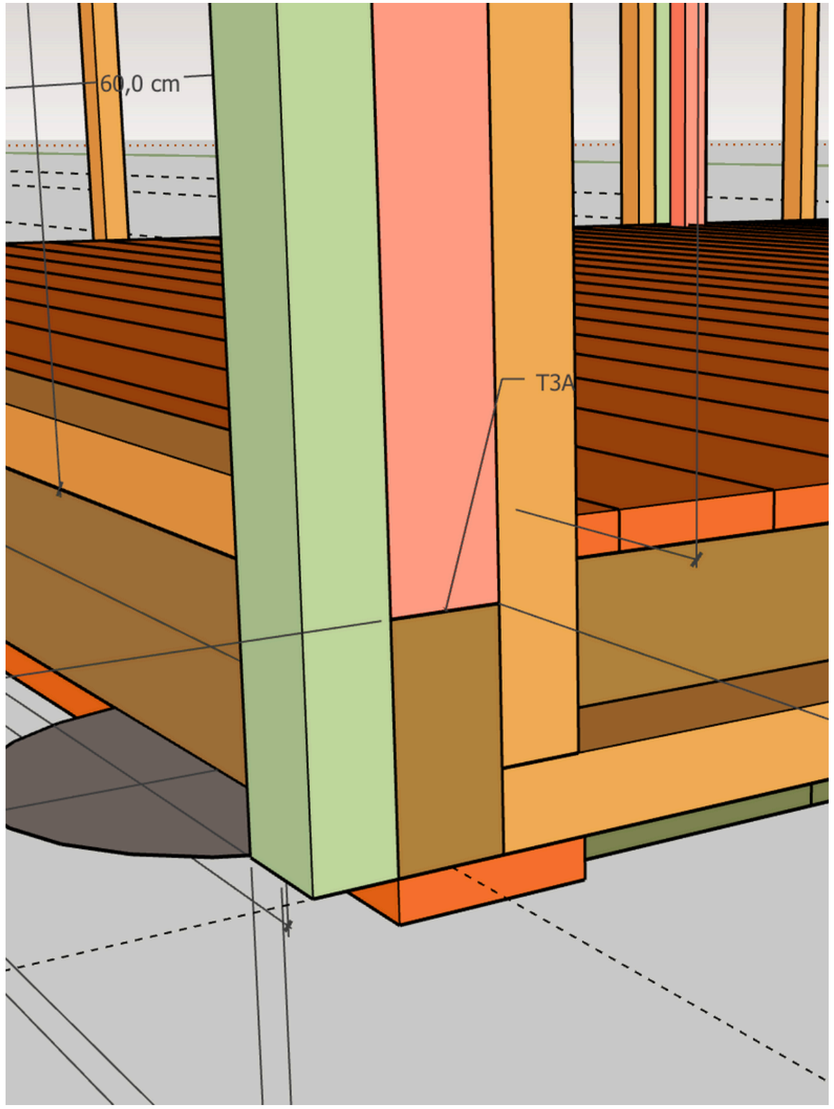
ASSEMBLING OF THE ELEMENTS

And start the roof
For that we stablished the same distance in between beams. Start for the extremities (see pag 83)



ASSEMBLING OF THE ELEMENTS

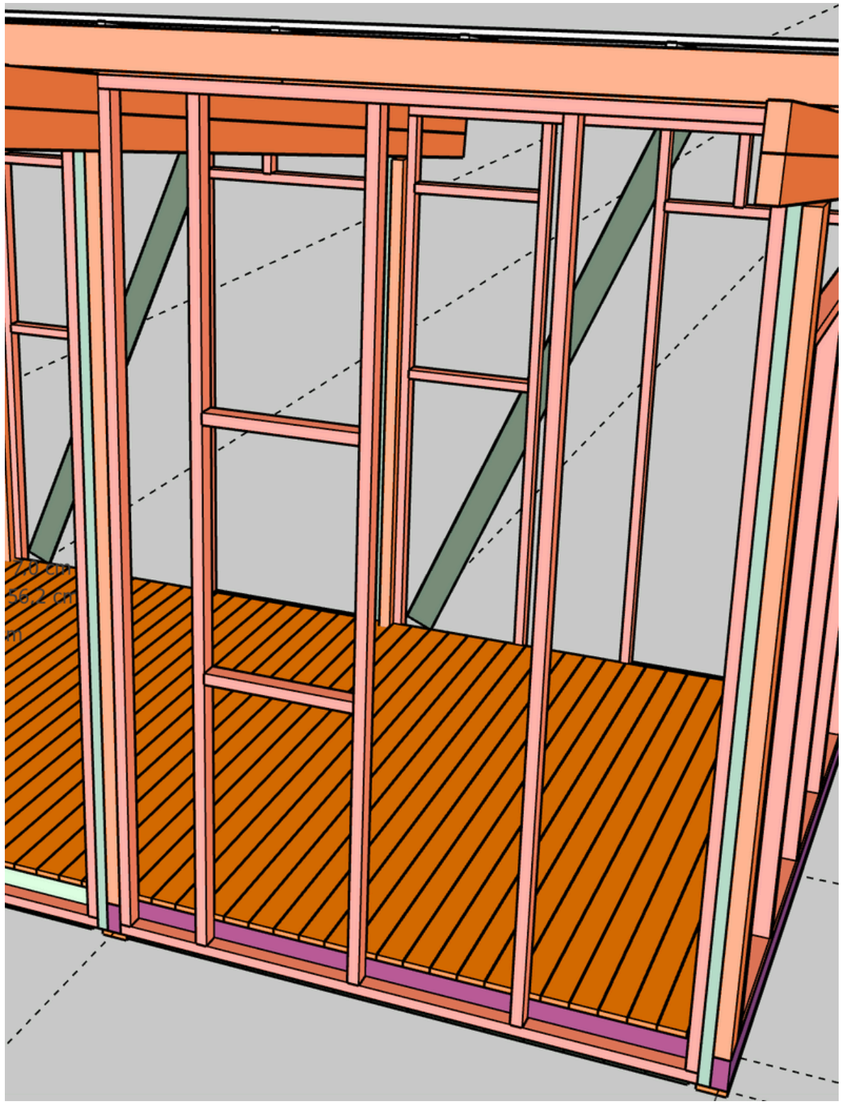
→ Assembling the porticos on the floor



1. **Brace** the portico before moving it (temporary diagonals)
2. **Choregraphy** : lift and place it on site
3. **Clamp** the portico on the beam of the floor
4. **Check** the level and screw temporary diagonals to the wooden planks of the floor
5. **Screw** definitively the portico in the beam of the floor :
   - 3 screws of 6x160 in diagonals, from each side.

ASSEMBLING OF THE ELEMENTS

→ Assembling the walls in the porticos :



1. **Brace** the wall before moving it (temporary diagonals)
2. **Choregraphy** : lift and place it on site
3. **Clamp** the wall on the beam of the floor and portico
4. **Check** the level
5. **Screw** definitively the wall to the portico :
    - Screws of 6x120 in diagonals, every 30cm
6. **Screw** definitvely the wall to the floor :
    - From inside to oustide : screws of 6x120 in diagonals, every 30cm

ASSEMBLING OF THE ELEMENTS





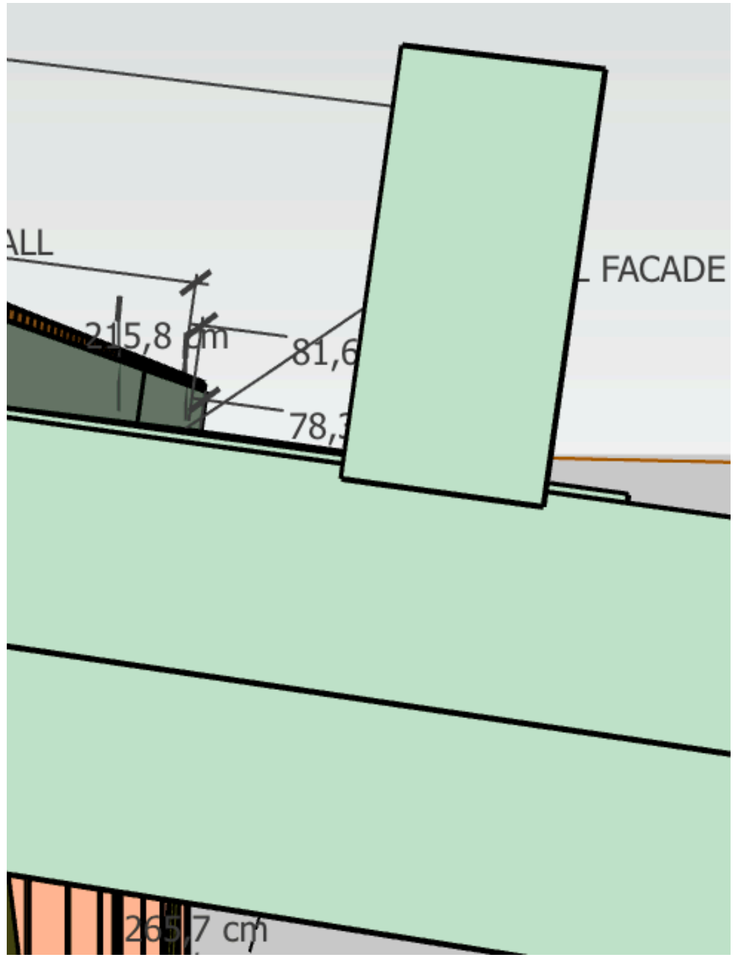


T12.
ROOF TEAM



ROOF TEAM

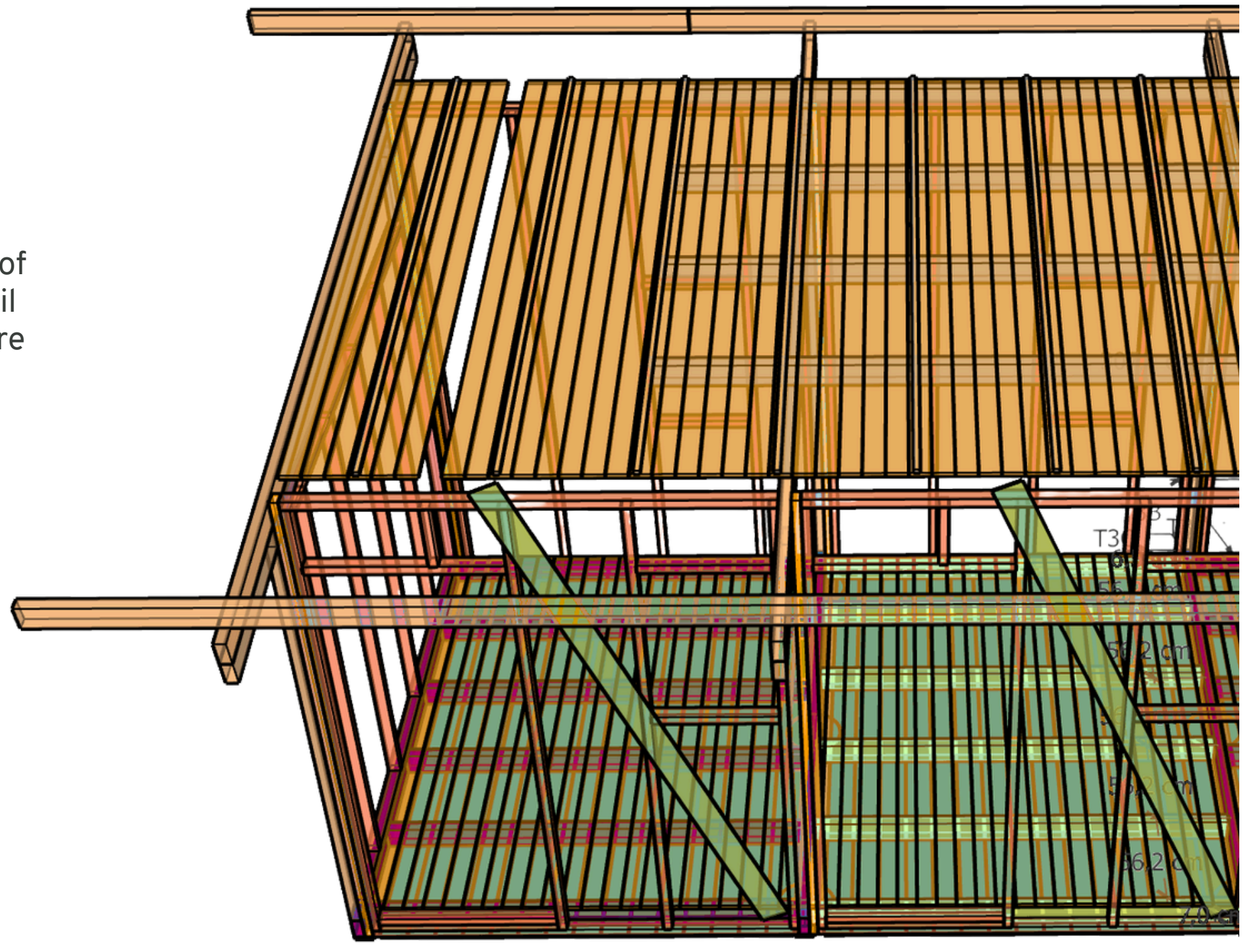
1. !! ***HELMETS** are mandatory for the people working under the roof.
2. Place the first and the last beam on the roof and place a string to alignthe next ones
3. Mark the place of the next beams on the porticos (the first and the last one and place a string)
4. Bring the beams on the roof and clamps them well
5. 2 screws in diagonal (6x160) on each beam





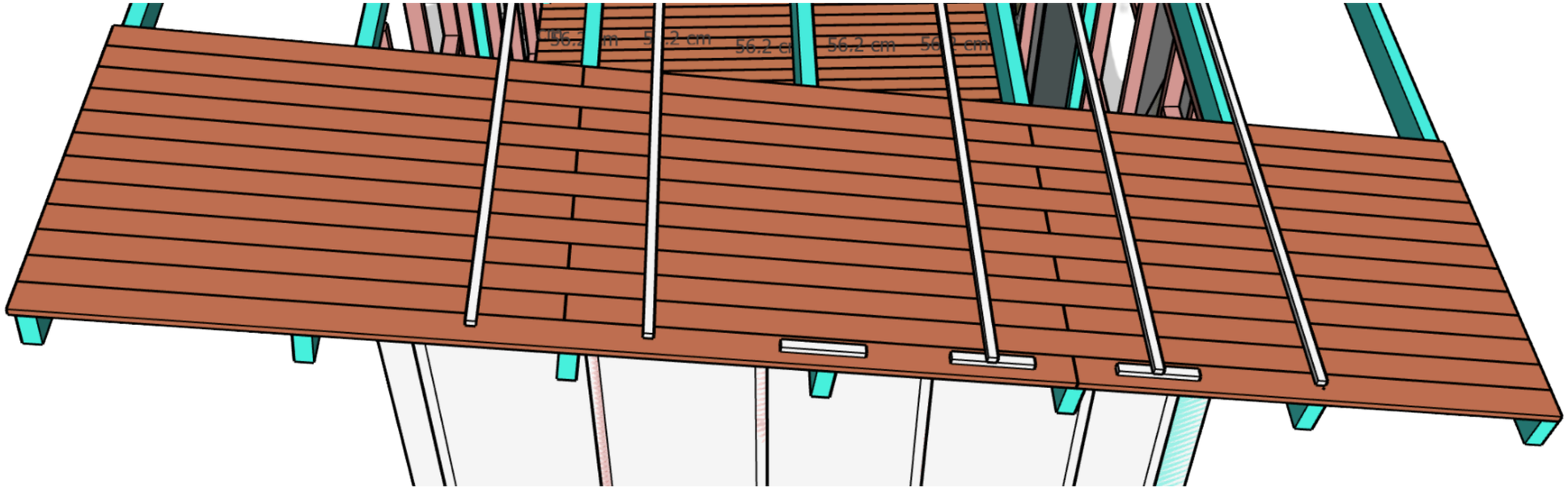
ROOF TEAM

1. To screw the top planks of the roof, start from one side. Be sure that you are perfectly parallel with the first portico
2. After that, start screw one by one
3. After each 10 planks, mesure from both extremities of the planck to be sure we have the same distante until the end of the roof, that hay we guarantee that we are going parallel



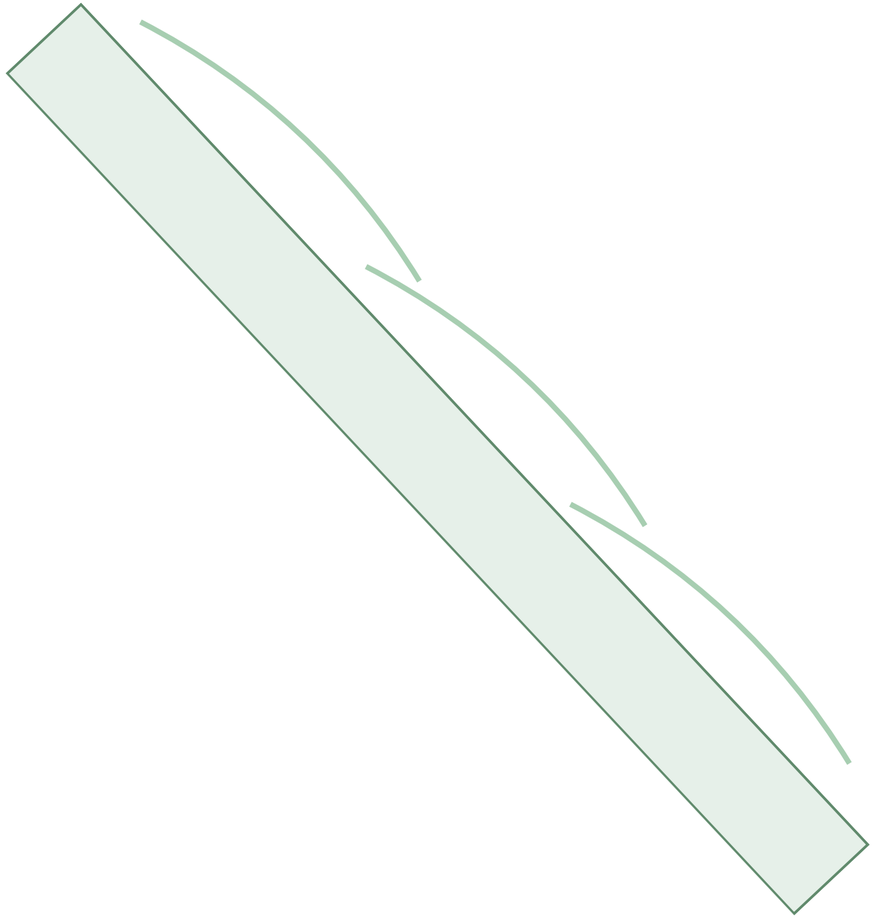
ROOF TEAM

Planks on the roof (22/100) : screws of 5x50, 1 screw on each beam each plank in zigzag



ROOF TEAM

1. Planks on the roof (22/100) : screws of 5x50, 1 screw on each beam each plank in zigzag
2. Staple the membrane on the roof (just in the intersections) every 40cm
3. Put the tape on the intersection, covering the staples
4. Screw the vertical liteaux of 30cm lenght (2 screws of 5x70 for each piece) every 60cm.
5. Add some wood supports (42/65) on the extremity beams to reach the same level as the roof.
6. Screw the horizontal liteaux (screw of 5x70 every 50cm)
7. Screw the metal sheets - start with the bottom row of sheets
   tirefond of 6x60 + rubber ring on the upper wave of the sheet (3 per line per plank)
8. Reinforce with screws if needed in the upper and lower extreme.





ROOF TEAM

T13 - T17
FINALISATION



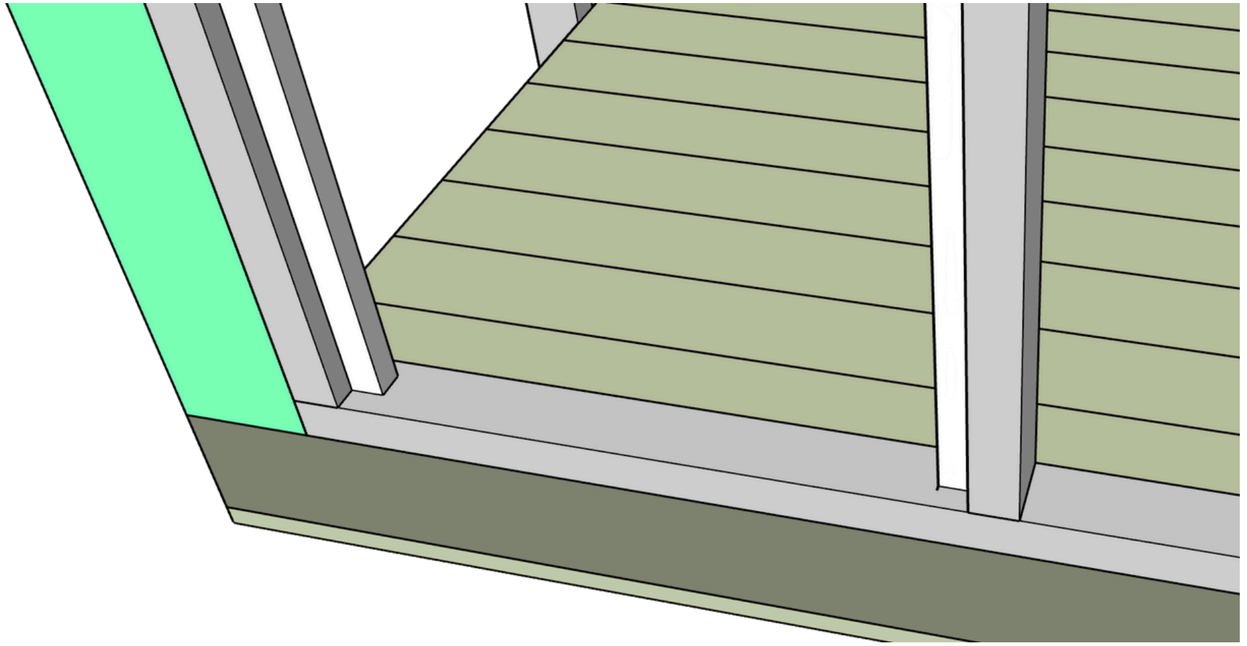
T.13 PREPARATION OF THE WALLS

→ Outside Waterproof layer

1 Fix the wood sticks on the lateral sides of the walls
a. screws of 5x50 every 50cm
this wood stick allow the light straw clay insulation to be wel
connected and fixed in between pillars

With this technique, we can compact with a temporary board and have the insulation as a final layer - visible from inside!





T.14 WATERPROOFING TEAM : 1ST LAYER

→ Outside Waterproof layer

1. **4 people :** prepare the mix for the first layer :
    - bath of clay
    - bring the thick sand
    - add the straw (shredded) : 3-4cm
    - do the mix with your feet on a tarp
2. **2 people :** make small balls of 10cm diameter with your hands (fast and furious - Toreto style)
3. **Thousand of people :** apply the plaster everywhere with your hands : start from the bottom to up. Be sure that you smash the plaster into the bambous. Try to work clean : not wasting too much plaster on the ground.

OBJECTIVE : 2 PEOPLE - 1 WALL 1 DAY.

4. Scratch the surface of the plaster to make sure the next layer can be well fixed on it





T.15 WATERPROOFING TEAM : 2ND LAYER

→ Outside Waterproof layer

1. **! Protection gloves**
   <u>Prepare the mix:</u>
   - bring the materials
   - 1vol lime + 1 vol clay + 3 vol (0-3mm) sand : 1cm
   - apply the plaster on the wall with tools
2. In the future : Lime paint

T.16 INSULATION OF THE FLOOR

→ Light straw clay

1. Make a clay bath
2. Put straw in the bath
3. Press the straw
4. Compress the straw in the flooring frames
5. After drying : screw the planks on the floor
   - screws 5x50, one on each plank

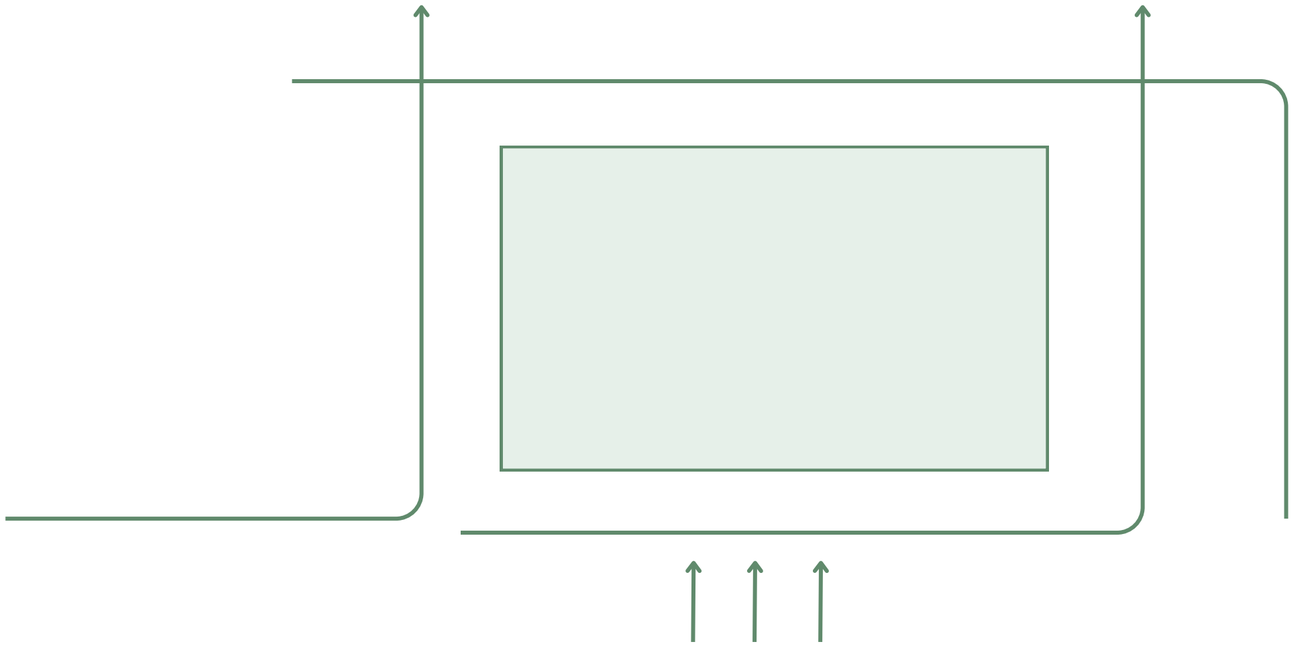


T.17 GUTTERS ON THE LAND

→ For the evacuation of water

Why drainage cuts are important on sloped ground ?

- On sloped terrain, **rainwater naturally flows downhill** and can collect near the foundations, causing moisture, erosion, or instability.
- **Creating drainage cuts** or channels around the building helps divert water away, keeping the foundations dry and stable.
- **GOOD DRAINAGE = A SAFE AND LONG-LASTING STRUCTURE**



Thermal behaviour in natural buildings:

A natural house works with the climate, not against it. Orientation: Face south to capture winter sun, shade in summer.

- **Thermal mass:** Earth, clay, or stone store and release heat slowly.
- **Insulation:** Straw, cork, or wool keep warmth in winter and coolness in summer.
- **Ventilation:** Let the house breathe with cross airflow and natural materials.
- **Moisture control:** Keep water out with good roofs, drainage, and breathable walls.

Comfort comes from balance — sun, air, and natural materials working together.

Natural Wall System – Summary

A natural wall is a living system made of layers that work together to support, protect, and regulate comfort.

- **Structure:** Cob, adobe, rammed earth, timber frame, or stone — gives strength and form.
- **Insulation:** Straw, hemp, cork, or wool — keeps warmth in and heat out.
- **Breathable layers:** Clay or lime plasters let moisture move, avoiding condensation.
- **Finishes:** Natural plasters and paints protect while allowing the wall to breathe.
- **Base & cap:** A solid foundation and wide roof overhang keep the wall dry.

A good natural wall has dry feet, a good hat, and a breathable skin.

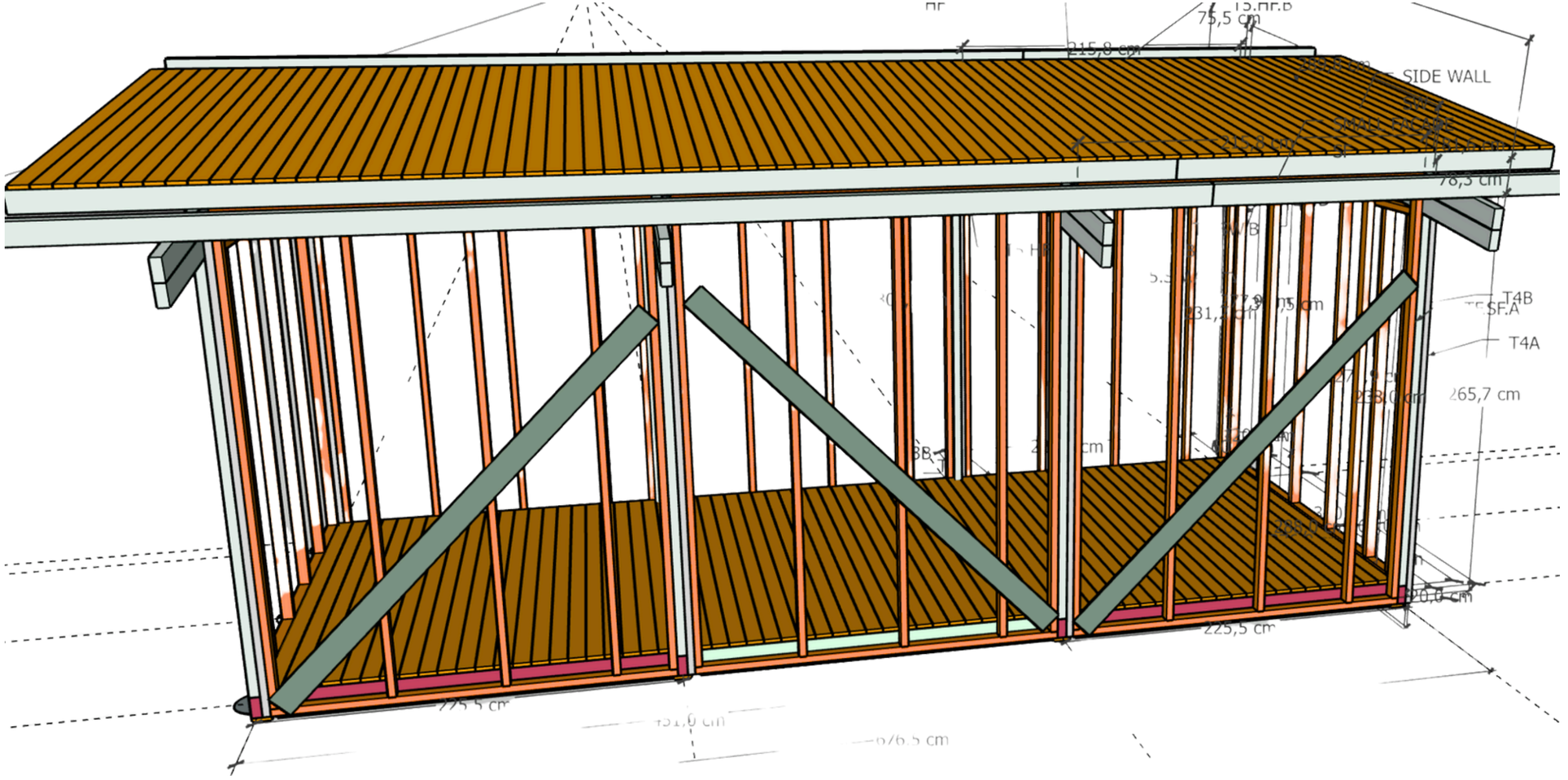


T.END

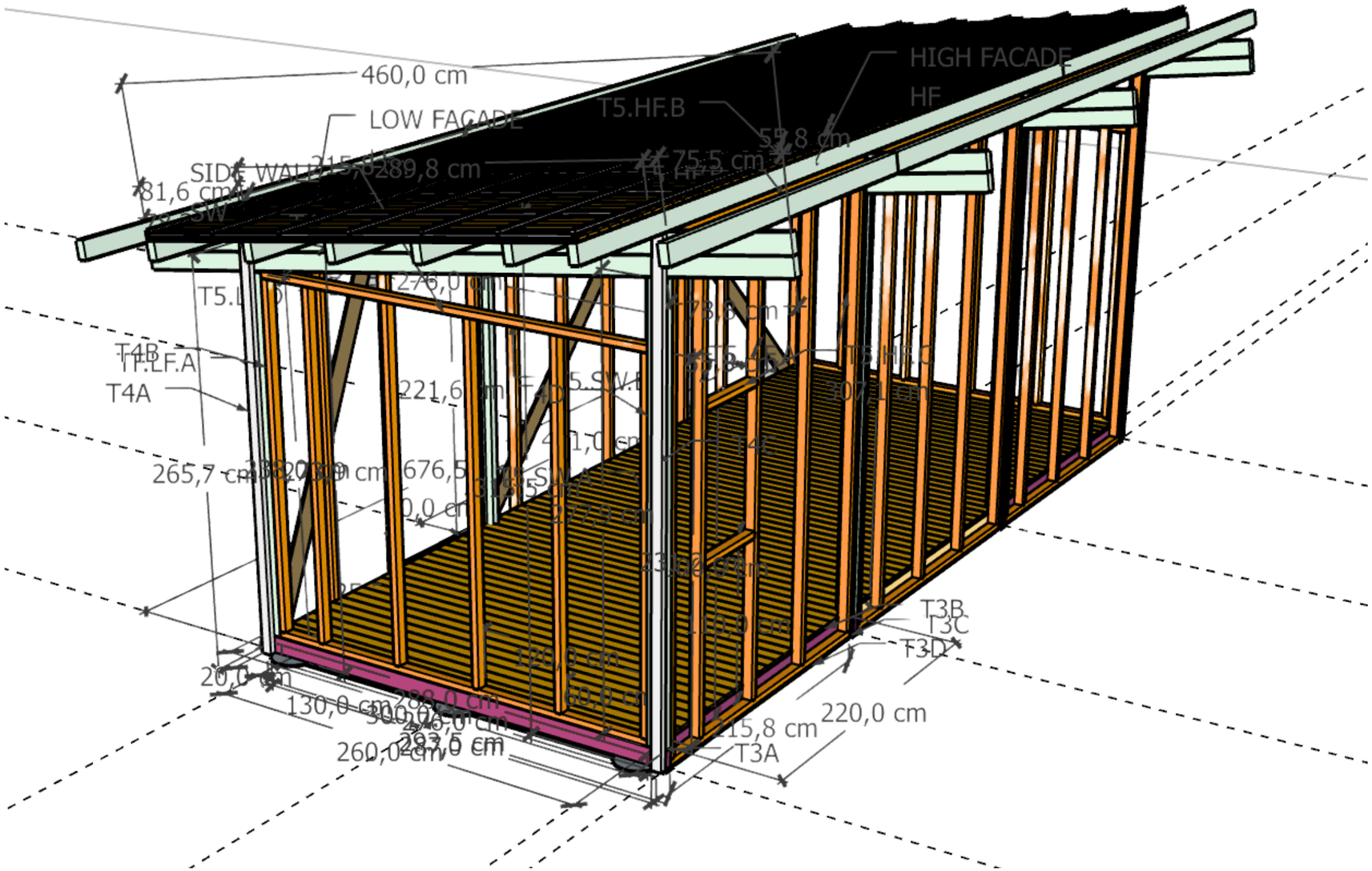
GENERAL OVERVIEW



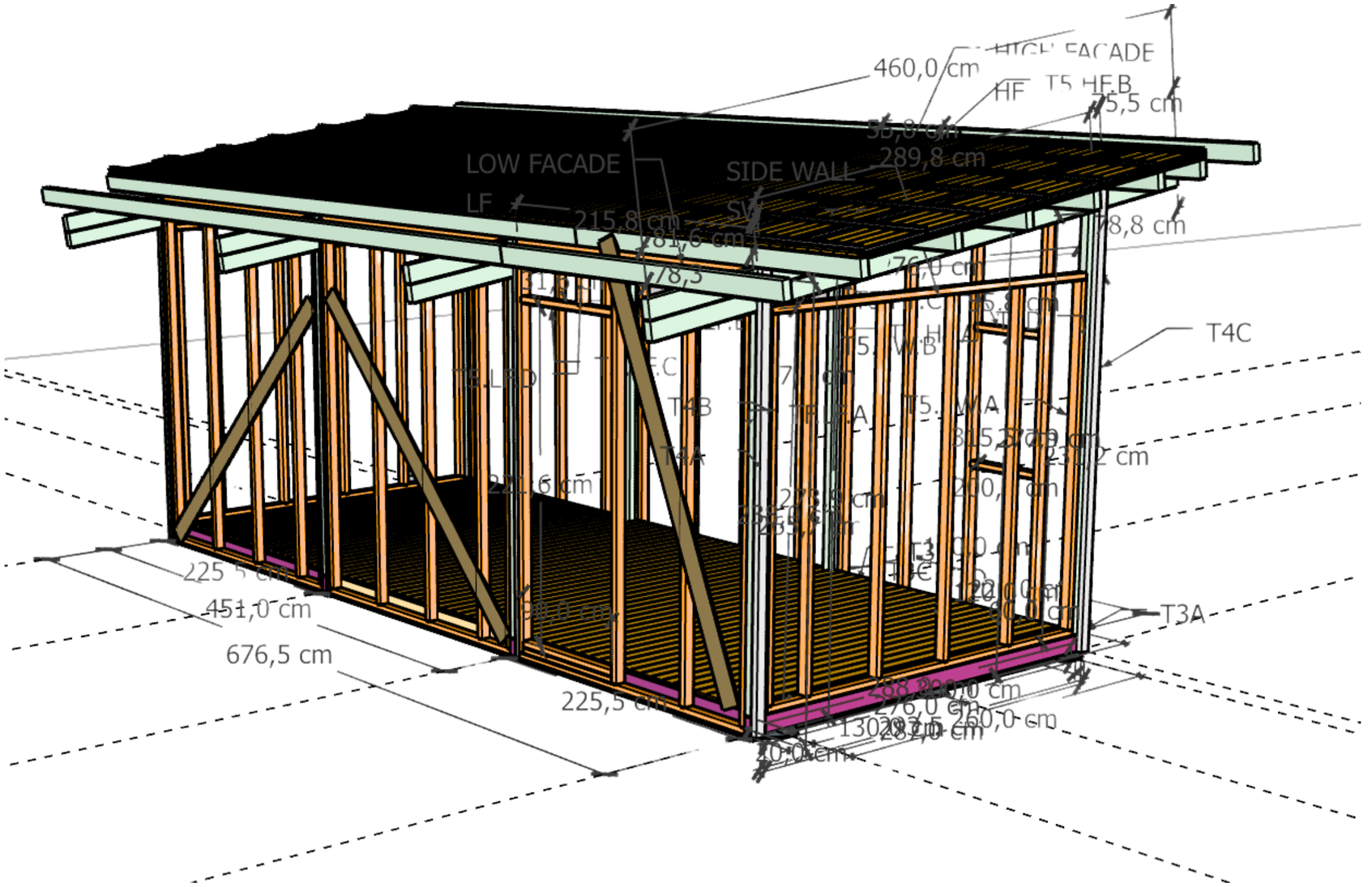
GENERAL OVERVIEW



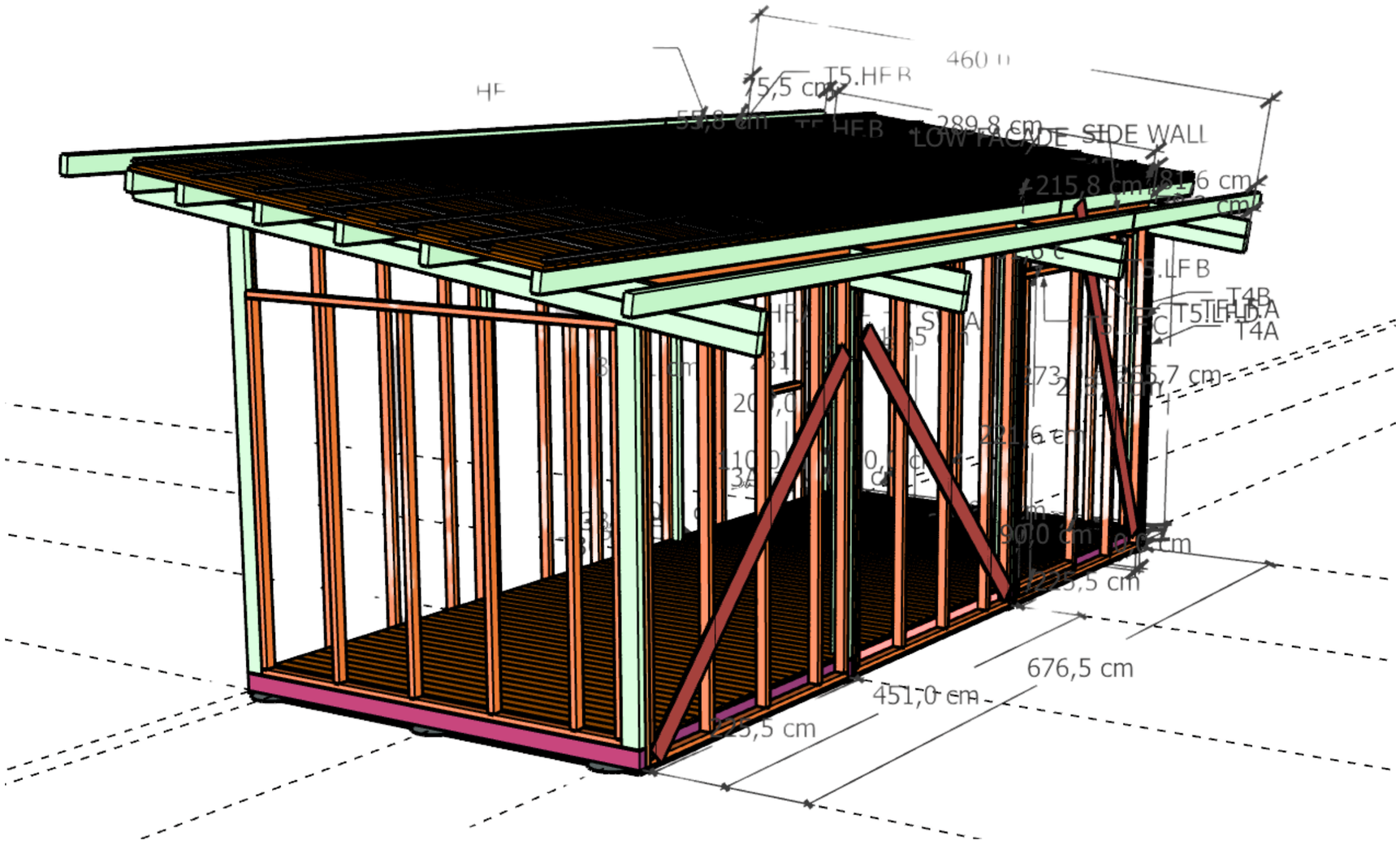
GENERAL OVERVIEW



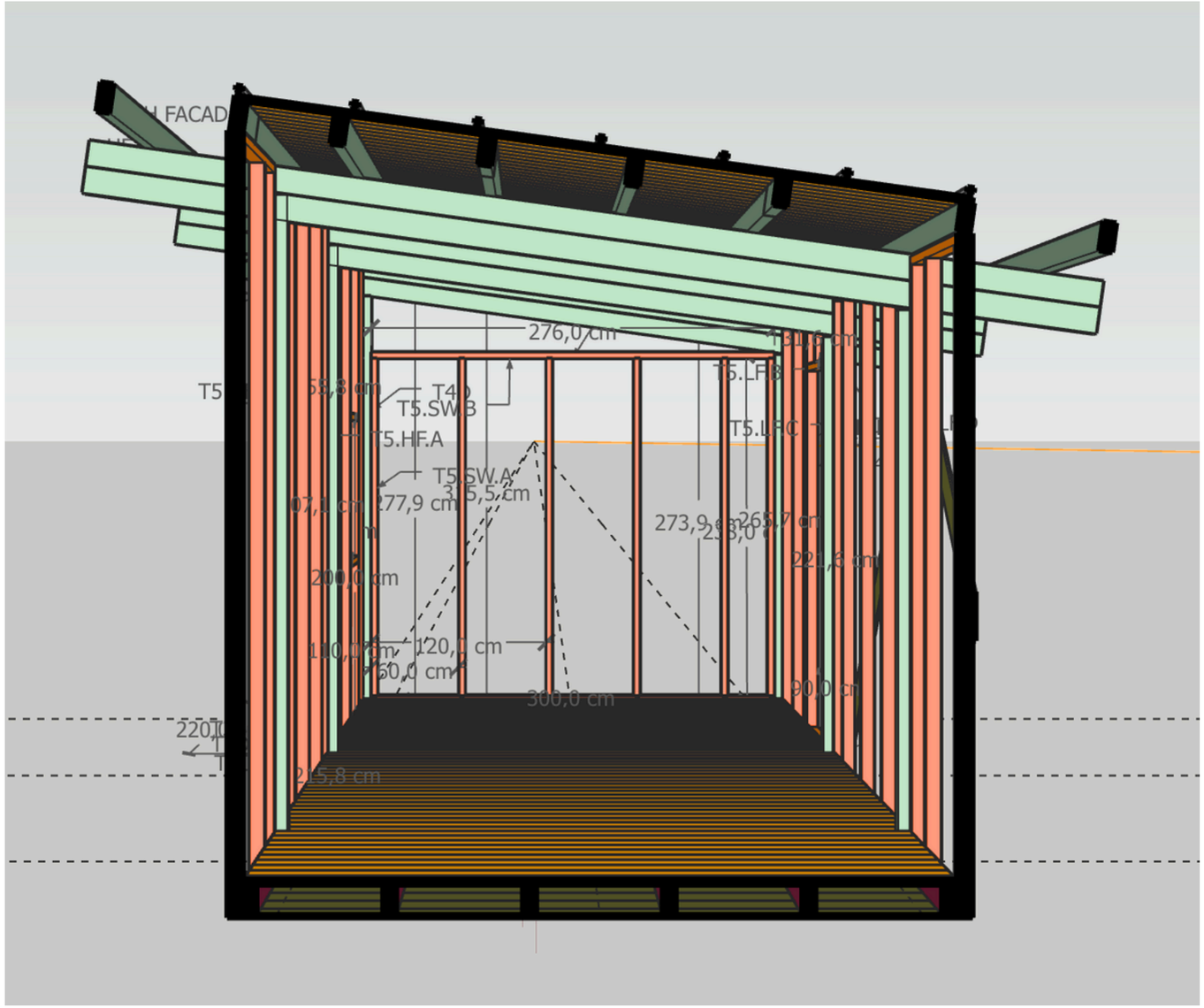
GENERAL OVERVIEW



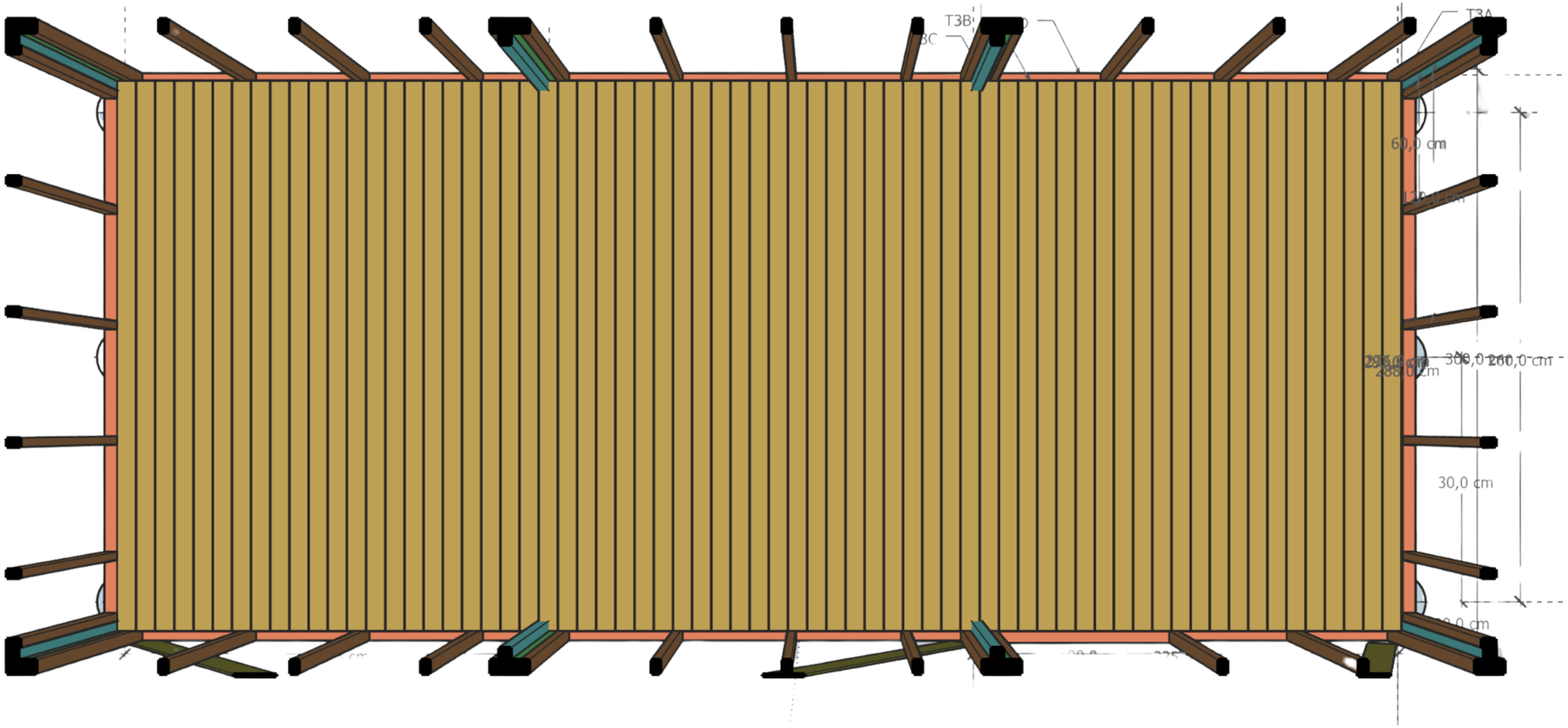
GENERAL OVERVIEW



GENERAL OVERVIEW



GENERAL OVERVIEW



GENERAL OVERVIEW



PLANNING

The main construction has been build during the workshop, having a mix of practical aqnd theoretical sessions, with an amount of an average of 15 people/day.

The following slides (planning) are not accurate to the real situation, many inbetween steps are not inthe planning (ex : pick up the stones, clean the bambous, ...) ***because they depend a lot on your construction site.***

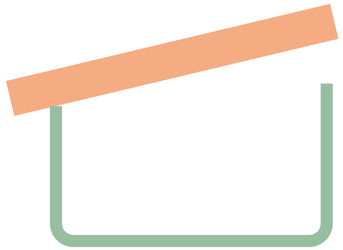


6	7	8	9	10	11	12	13
Présentation, Preparing the field, presentation project	T1 (measurements + 1 foundation)	OFF	T1 (3,5 foundations)	T1 (8 foundations)	T6 : floor on foundations	T7	T9
Safety, maintenance, tools and posture	T2 (cutting)		T1 T2 (cutting all beams done)	T2 (cutting planks)	T1 T2 (cutting all beams done)	T8	
Cleaning building area, bring the wood, bring the stones	(Prepare the floor) T3 : 1st floor assembled T4 : 1 Portico T5 prep		T3: planks on the 1st floor + 2nd floor assembled T4 : 1 Portico T5 : 1 wall	T3 : Planks on 2nd floor + help the T5 T4 : 2 porticos T5	T3: planks on the 1st floor + 2nd floor assembled T4 : 1 Portico T5 : 1 wall		

14	15	16	17	18	19	20
Bamboo, roof, 3rd floor	DAY OFF	Finish the roof				OFF

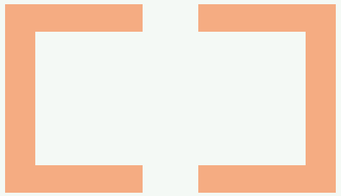
PLANNING SHEET :

→ Wednesday



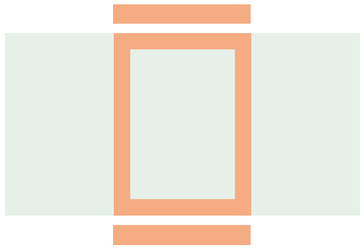
- Horizontal sticks
- **Metal sheets** : try to organize your planning to never step on the sheets

TEAM 13
Total : 3ppl



- **2 people :** Finish to fix and check the bamboo
- **2 people :** Finish to fix the outside sticks
- **4 people :** Do the mix.
- **Everyone :** Plaster the walls (check the technical sheet)

TEAM 15
Total : 8ppl + extras



- **2 people :** focus on the floor
- Cut the planks
- Oil the planks
- Instal the metallic grid
- Install the 3rd floor on site
- **2 people :** focus on the walls
- Place the bambous on the walls
- Install the 2 walls on site
- Place the outside sticks

TEAM 10
Total : 4ppl

PLANNING SHEET :

→ Thursday



- Finish the plaster everywhere

TEAM 15
Total : 6ppl

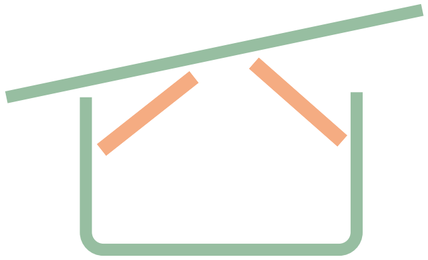


- Start and finish the insulation of the floor

TEAM 17
Total : 12ppl

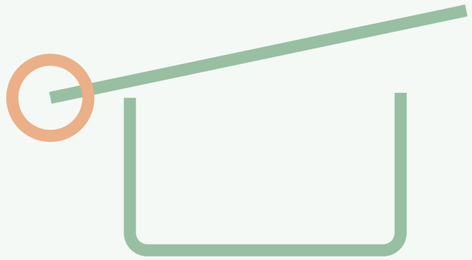
PLANNING SHEET :

→ Friday



- Interior diagonals

Total : 2ppl



- Finish the gutter

Total : 2ppl

- Finish all the rest that is still not done

Total : all the rest

PLANNING SHEET :

→ *Saturday*



- 2nd layer of plaster

TEAM 18
Total : 12ppl



- Plank the floor

TEAM 17
Total : 4ppl


Now it's your turn !



THE END

ON HOW TO BUILD A HOUSE

Erasmus+ Training Course

Re-Joyce in resilience: natural building and community-led design



Co-funded by the European Union